GATEWAY SCIENCE SUITE

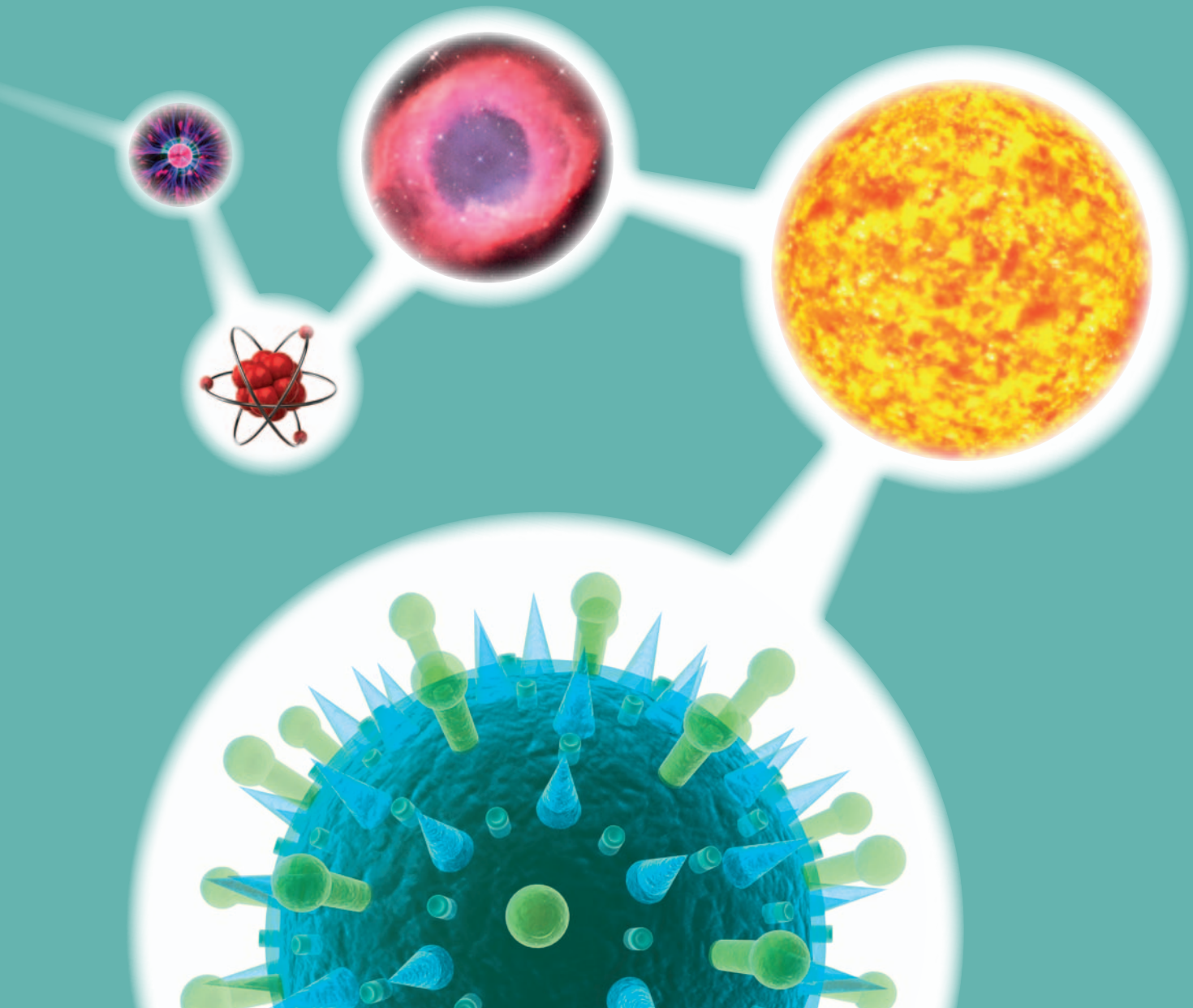
GCSE SCIENCE B

ACCREDITED SPECIFICATION

J261

VERSION 2

MAY 2012



WELCOME TO GCSE SCIENCES

THOUSANDS OF TEACHERS ALREADY UNLEASH THE JOY OF SCIENCE WITH OCR.

A FEW GOOD REASONS TO WORK WITH OCR

- You can enjoy the **freedom and excitement** of teaching science qualifications which have been developed to help you inspire students of all abilities.
- We've built specifications **with you in mind**, using a clear and easy-to-understand format, making them straightforward for you to deliver.
- Our **clear and sensible assessment** approach means that exam papers and requirements are clearly presented and sensibly structured for you and your students.
- **Pathways for choice** – we have the broadest range of science qualifications and our GCSEs provide an ideal foundation for students to progress to more-advanced studies and science-related careers.
- **Working in partnership to support you** – together with teachers we've developed a range of practical help and support to save you time. We provide everything you need to teach our specifications with confidence and ensure your students get as much as possible from our qualifications.
- **A personal service** – as well as providing you with lots of support resources, we're also here to help you with specialist advice, guidance and support for those times when you simply need a more individual service.

HERE'S HOW TO CONTACT US FOR SPECIALIST ADVICE:

By phone: 01223 553998

By email: science@ocr.org.uk

By online: http://answers.ocr.org.uk

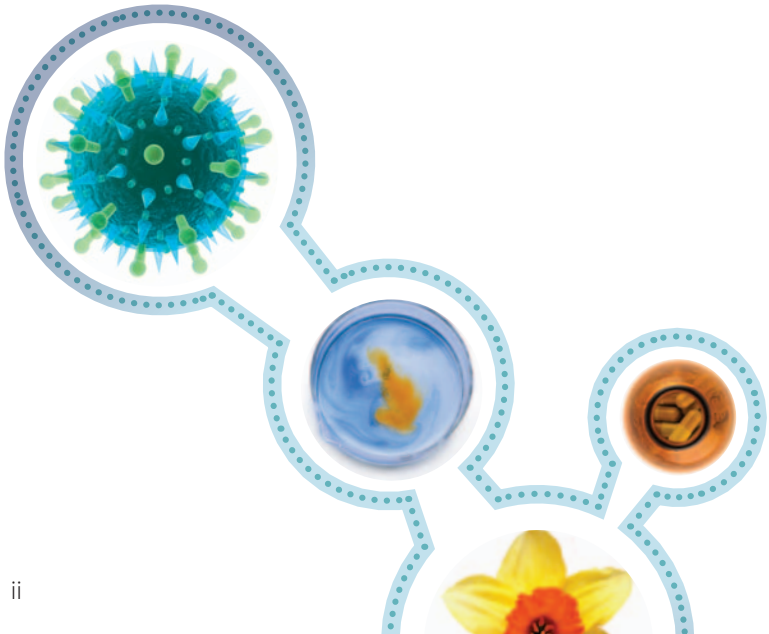
By fax: 01223 552627

By post: Customer Contact Centre, OCR, Progress House, Westwood Business Park, Coventry CV4 8JQ

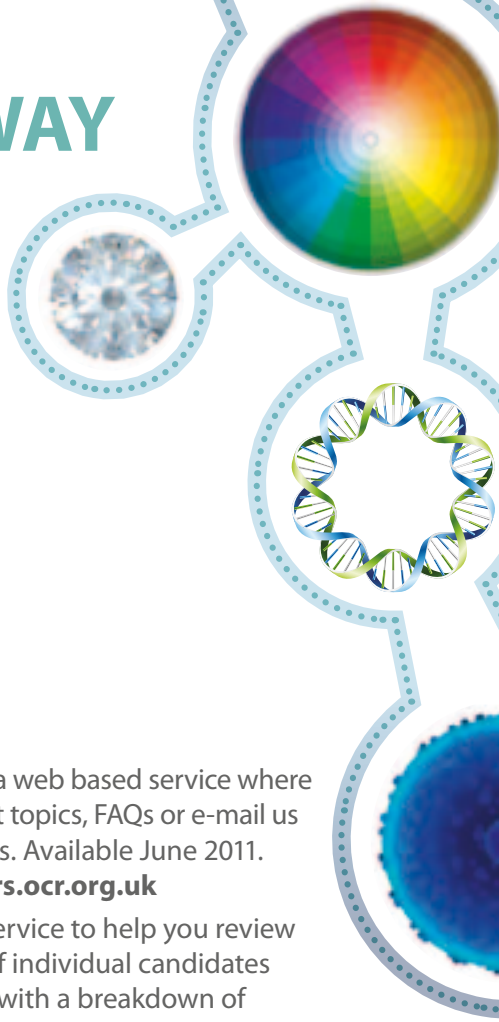
DON'T FORGET

– you can download a copy of this specification and all our support materials at

www.ocr.org.uk/gcse2012



SUPPORTING YOU ALL THE WAY



Our aim is to help you at every stage and we work in close consultation with teachers and other experts to provide a practical package of high quality resources and support.

Our support materials are designed to save you time while you prepare for and teach our new specifications. In response to what you have told us we are offering detailed guidance on key topics, controlled assessment and curriculum planning.

Our essential FREE support includes:

Materials

- Specimen assessment materials and mark schemes
- Guide to controlled assessment
- Sample controlled assessment material
- Exemplar candidate work
- Teacher's handbook
- Sample schemes of work and lesson plans
- Guide to curriculum planning
- Frequently asked questions
- Past papers.

You can access all of our support at:
www.gcse-science.com

Training

Our GCSE Science Get Started events:

- include useful information about our specifications direct from the experts
- are designed to assist you in preparing to teach
- provide you with an opportunity to speak face-to-face with our team.

We're also developing online support and training for those unable to get away from school.

Go to **www.ocr.org.uk/science2011/training** for full details and to book your place.

Science Community

Join our social network at **www.social.ocr.org.uk** where you can start discussions, ask questions and upload resources.

Services

- **Answers @ OCR –** a web based service where you can browse hot topics, FAQs or e-mail us with your questions. Available June 2011. Visit **http://answers.ocr.org.uk**
- **Active Results** – service to help you review the performance of individual candidates or a whole school, with a breakdown of results by question and topic.
- **Local cluster support networks** – supported by OCR, you can join our local clusters of centres who offer each other mutual support.

Endorsed publisher partner materials

We're working closely with our publisher partner Collins Education to ensure effective delivery of endorsed materials when you need them.
Find out more at:
www.collinseducation.com/newgcsescience

WHAT TO DO NEXT

1) Sign up to teach – let us know you will be teaching this specification to ensure you receive all the support and examination materials you need. Simply complete the online form at **www.ocr.org.uk/science/signup**

2) Become an approved OCR centre – if your centre is completely new to OCR and has not previously used us for any examinations, visit **www.ocr.org.uk/centreapproval** to become an approved OCR centre.

GATEWAY SCIENCE SUITE

Science in Action

Understand the questions that science can answer. Unpick the scientific concepts and investigate their familiar applications through active learning.

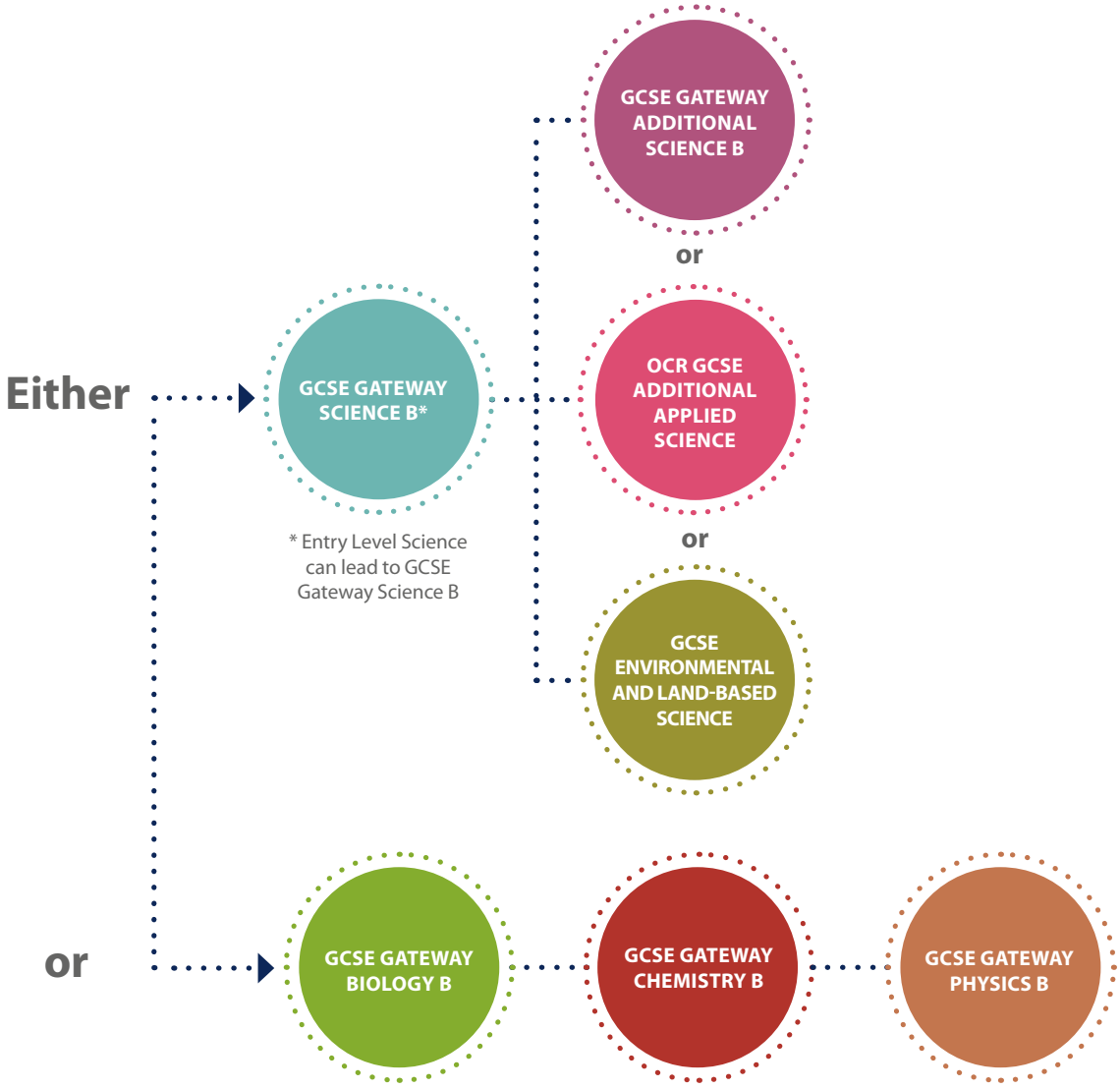
Our Gateway Science Suite gives you and your students:

- an emphasis on getting more involved in the learning process through a variety of interesting activities and experiences, identifying links to scientific ideas and their implications for society
- the opportunity to develop scientific explanations and theories.

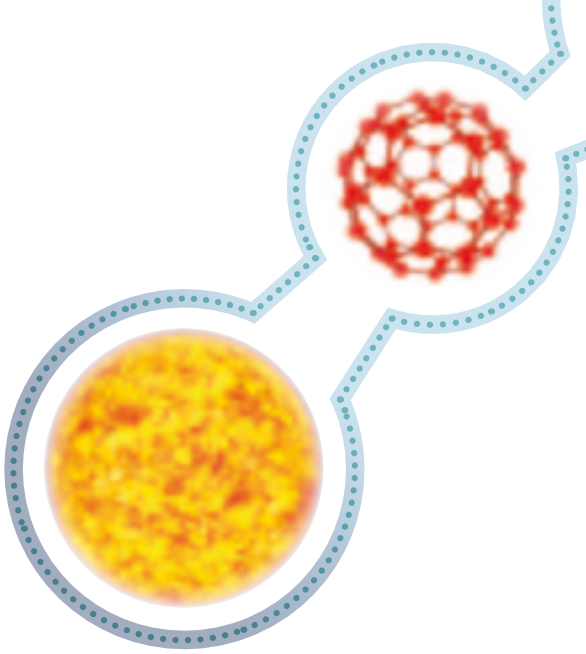
KEY FEATURES

- **Flexible assessments**, which can be carried out at the end of the course or at times during the course when students' understanding is at its best.
- **Unique assessment approach** – more straightforward to manage and puts you in greater control, while making it easier to manage resits (for example 40% weighted unit resit of one unit rather than two and meets the terminal rule).
- **Practical work** is at the heart of the Gateway Science Suite.

POSSIBLE GCSE COMBINATIONS



GCSE SCIENCE B



KEY FEATURES

GCSE Science B:

- identifies the activities and experiences learners will come across in everyday life, and links these to scientific ideas and their implications for society
- provides the opportunity to acquire the scientific skills, knowledge and understanding necessary for life as a citizen.

COURSE OVERVIEW

ASSESSMENT OVERVIEW

UNIT B711
Module B1: Understanding Organisms
Module C1: Carbon Chemistry
Module P1: Energy For The Home

75 marks
1 hour 15 minutes
written paper

35% of total GCSE

UNIT B712
Module B2: Understanding Our Environment
Module C2: Chemical Resources
Module P2: Living For The Future

85 marks
1 hour 30 minutes
written paper

40% of total GCSE

Two written exams, assessed externally by OCR, each of which:

- is offered in Foundation and Higher Tiers
- uses structured questions (there is no choice of questions)
- assesses the quality of written communication

Unit B712 also includes a 10 mark data response section which assesses AO3 (analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence)

UNIT B713
Controlled assessment

48 marks
Approx 6 hours

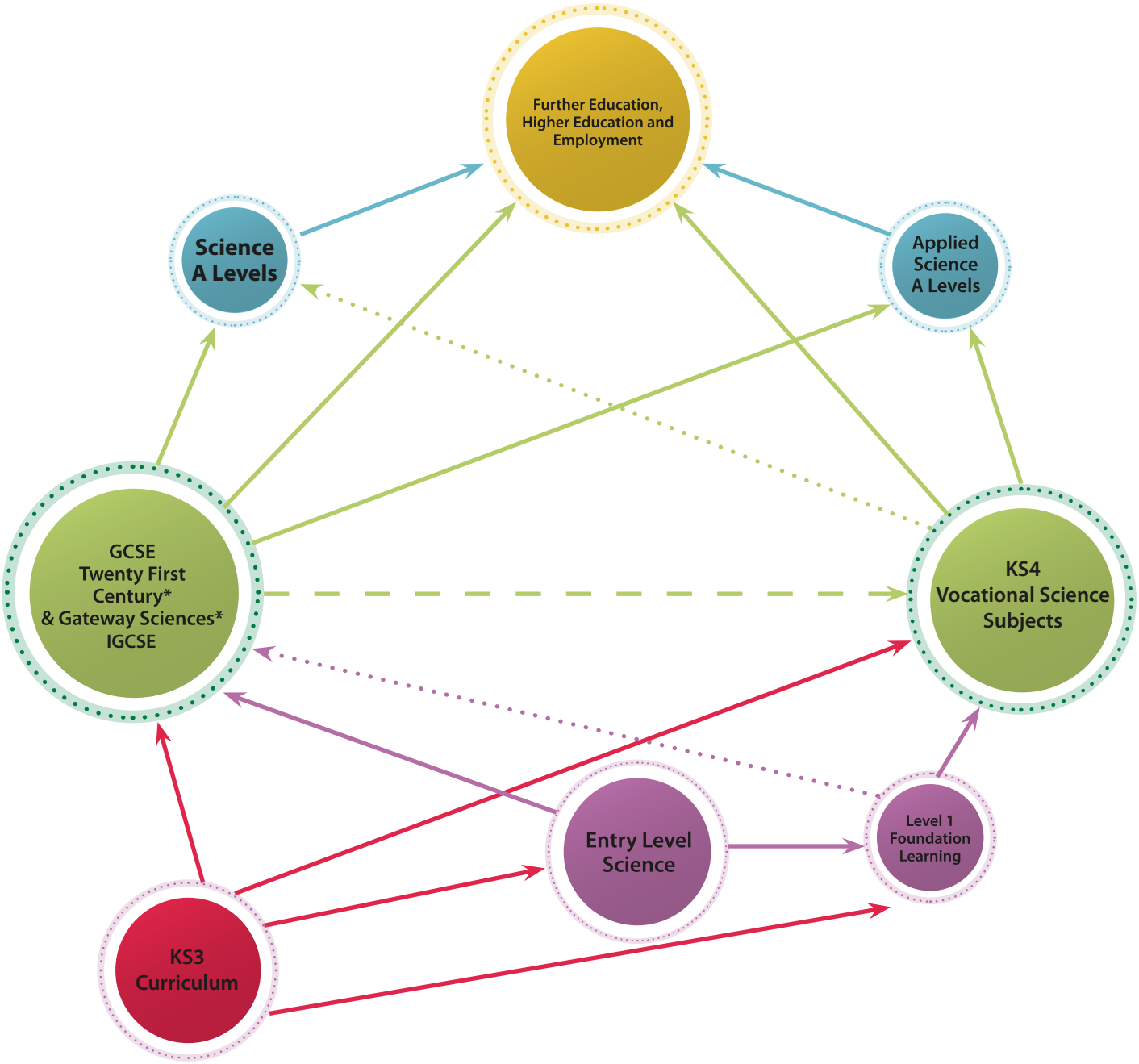
25% of total GCSE

Comprises one assessment task, split into three parts

Assessed by teachers, internally standardised and then externally moderated by OCR

Assesses the quality of written communication

PROGRESSION PATHWAYS IN SCIENCE



This could be a progression route along a particular curriculum pathway. (Stage, not age pathways)

This could be a progression route however students would require additional support.

Alternative qualification options

* Offered as
Science, Additional Science, Biology, Chemistry and Physics.

Contents

Contents

Introduction to the Gateway Suite

1

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.

OCR also offers a specification in GCSE Additional Applied Science which may be taken as an alternative to GCSE Additional Science.

2 Introduction to GCSE Science B

2.1 Overview of GCSE Science B

Unit B711 *Science modules B1, C1, P1*

This is a tiered unit offered in Foundation and Higher Tiers.

Written paper
1 hour 15 mins – 75 marks
35% of the qualification

Question paper comprises structured questions.
Candidates answer all questions.

+

Unit B712 *Science modules B2, C2, P2*

This is a tiered unit offered in Foundation and Higher Tiers.

Written paper
1 hour 30 mins – 85 marks
40% of the qualification

Question paper comprises structured questions and analysis of data.
Candidates answer all questions.

+

Unit B713 *Science controlled assessment*

This unit is not tiered.

Controlled assessment
48 marks
25% of the qualification

2.2 What is new in GCSE Science B

	What stays the same?	What changes?
Structure	• Three units, comprising two externally assessed units and one internally assessed unit. • Externally assessed units are tiered – Foundation and Higher Tier. • Unit weightings – Unit B711 still 35%, Unit B712 still 40%. • Controlled assessment still 25% weighting.	• The course will be assessed as linear.
Content	• Content is divided into 6 modules, B1, B2, C1, C2, P1 and P2.	
Assessment	• Papers include structured questions and objective questions. • The internally assessed unit is based on a single investigative task divided into three parts. • There will be a choice of controlled assessment tasks, set by OCR, valid for entry in one year only. • Unit B711 paper is 1 hour 15 mins long, with a total of 75 marks. • Unit B712 paper is 1 hour 30 mins long, with a total of 85 marks including a 10 mark analysis of evidence section. • How Science Works will be assessed in all units. • Quality of written communication will be assessed in all units.	• New 100% assessment rules apply to Science GCSEs. All units, including written papers, available for assessment in June series only.

2.3 Guided learning hours

GCSE Science B requires 120–140 guided learning hours in total.

2.4 Aims and learning outcomes

GCSE specifications in Science should encourage learners to be inspired, motivated and challenged by following a broad, coherent, practical, satisfying and worthwhile course of study. They should provide insight into and experience of how science works, stimulating learners' curiosity and encouraging them to engage with science in their everyday lives and to make informed choices about further study and about career choices.

The aims of this specification are to enable candidates to:

- develop their knowledge and understanding of the material, physical and living worlds
- develop their understanding of the nature of science and its applications and the interrelationships between science and society
- develop an understanding of the importance of scale in science
- develop and apply their knowledge and understanding of the scientific process through hypotheses, theories and concepts
- develop their understanding of the relationships between hypotheses, evidence, theories and explanations
- develop their awareness of risk and the ability to assess potential risk in the context of potential benefits
- develop and apply their observational, practical, enquiry and problem-solving skills and understanding in laboratory, field and other learning environments
- develop their ability to evaluate claims based on science through critical analysis of the methodology, evidence and conclusions
- develop their skills in communication, mathematics and the use of technology in scientific contexts.

2.5 Prior learning

Candidates entering this course should have achieved a general educational level equivalent to National Curriculum Level 3, or an Entry 3 at Entry Level within the National Qualifications Framework.

Content of GCSE Science B

3

3.1 Summary of content

The specification content is presented as six modules which are listed below. 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 requires approximately 2½ hours teaching time.

Module B1: *Understanding Organisms*	Module C1: *Carbon Chemistry*	Module P1: *Energy For The Home*
a Fitness and health	a Making crude oil useful	a Heating houses
b Human health and diet	b Using carbon fuels	b Keeping homes warm
c Staying healthy	c Clean air	c A spectrum of waves
d The nervous system	d Making polymers	d Light and lasers
e Drugs and you	e Designer polymers	e Cooking and communicating using waves
f Staying in balance	f Cooking and food additives	f Data transmission
g Controlling plant growth	g Smells	g Wireless signals
h Variation and inheritance	h Paints and pigments	h Stable Earth
Module B2: *Understanding Our Environment*	**Module C2: *Chemical Resources***	**Module P2: *Living For The Future (Energy Resources)***
a Classification	a The structure of the Earth	a Collecting energy from the Sun
b Energy flow	b Construction materials	b Generating electricity
c Recycling	c Metals and alloys	c Global warming
d Interdependence	d Making cars	d Fuels for power
e Adaptations	e Manufacturing chemicals: making ammonia	e Nuclear radiations
f Natural selection	f Acids and bases	f Exploring our Solar System
g Population and pollution	g Fertilisers and crop yields	g Threats to Earth
h Sustainability	h Chemicals from the sea: the chemistry of sodium chloride	h The Big Bang

3.2 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 Organisms)

Item code and title: e.g. B1a: Fitness and health

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 practical and research activities 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.

Module Code and Title

Item code and title: e.g. B1a: Fitness and health

Links to other items: 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.

It may be necessary to teach the content of the Foundation Tier only column to provide the underpinning knowledge required by Higher Tier candidates.

Candidates who are following this specification should have underpinning knowledge of science through familiarity with the science content of the Key Stage 3 programme of study within the National Curriculum.

3.3 Fundamental Scientific Processes

Fundamental Scientific Processes

Item Sa: How Science Works

Summary: In addition to knowledge of the scientific explanations that are detailed in sections 3.4 – 3.9 below, candidates require an understanding of the fundamental scientific processes that underpin these explanations.

Links to other items	Assessable learning outcomes Foundation Tier only: low demand
C1e, P1a, P1b, P1c, P1d, P1e, P2a, P2c, P2d, P2f	Describe a simple scientific idea using a simple model.
B1h, B2f, C2g, C2a, P1h P2a, P2c, P2g, P2h	Identify two different scientific views or explanations of scientific data.
B2e, B2f, C1c, C1e, C2a	Recall that scientific explanations (hypotheses) are: • used to explain observations • tested by collecting data/evidence.
B2f, C2a, P1c, P2h	Describe examples of how scientists use a scientific idea to explain experimental observations or results.
B2f, C2a, P1e, P2c, P2h	Recognise that scientific explanations are provisional but more convincing when there is more evidence to support them.
B1b, B1c, B2f, B2g, C1a, C1b, C1e, C1g, C2a, C2g, P1e, P1h, P2a, P2c, P2d, P2h	Identify different views that might be held regarding a given scientific or technological development.
B1h, B2e, B2g, C1a, C1c, C1g, C2c, C2d, C2e, C2g, P1f, P1h, P2a, P2b, P2c, P2e, P2g	Identify how a scientific or technological development could affect different groups of people or the environment.
B1c, B1a, B1b, B1h, B2g, C1b, C1c, C1e, P1e, P1h, P2c, P2e	Describe risks from new scientific or technological advances.
B2g, C2d, P1b, P1e, P1h, P2c, P2e	Distinguish between claims/opinions and scientific evidence in sources.
B2f, C2a, P1e, P1h, P2c, P2h	Recognise the importance of the peer review process in which scientists check each other's work.
B1a, B1b, B1c, B1e, B2b, B2d, C2e, P1a, P1b, P1g, P2b, P2c	Present data as tables, pie charts or line graphs, identify trends in the data, and process data using simple statistical methods such as calculating a mean.
B1a, B1e, C2a, P1e, P1h, P2c, P2h	Explain how a conclusion is based on the scientific evidence which has been collected.

Fundamental Scientific Processes

Summary (cont.): Studying these processes will provide candidates with an understanding of:

- how scientific explanations have been developed,
- their limitations, and
- how they may impact on individuals and society.

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain a scientific process, using ideas or models.	Explain a complex scientific process, using abstract ideas or models.
Describe (without comparing) the scientific evidence that supports or refutes opposing scientific explanations.	Evaluate and critically compare opposing views, justifying why one scientific explanation is preferred to another.
Explain how a scientific idea has changed as new evidence has been found.	Identify the stages in the development of a scientific theory in terms of the way the evidence base has developed over time alongside the development of new ways of interpreting this evidence.
Describe examples of how scientists plan a series of investigations/make a series of observations in order to develop new scientific explanations.	Understand that unexpected observations or results can lead to new developments in the understanding of science.
Recognise that scientific explanations are provisional because they only explain the current evidence and that some evidence/observations cannot yet be explained.	Recognise that confidence increases in provisional scientific explanations if observations match predictions, but this does not prove the explanation is correct.
Explain how the application of science and technology depends on economic, social and cultural factors.	Describe the ways in which the values of society have influenced the development of science and technology.
Identify some arguments for and against a scientific or technological development, in terms of its impact on different groups of people or the environment.	Evaluate the application of science and technology, recognising the need to consider what society considers right or wrong, and the idea that the best decision will have the best outcome for the majority of the people involved.
Suggest ways of limiting risks and recognise the benefits of activities that have a known risk.	Analyse personal and social choices in terms of a balance of risk and benefit.
Evaluate a claim/opinion in terms of its link to scientific evidence.	Evaluate critically the quality of scientific information or a range of views, from a variety of different sources, in terms of shortcomings in the explanation, misrepresentation or lack of balance.
Explain how publishing results through scientific conferences and publications enables results to be replicated and further evidence to be collected.	Explain the value of using teams of scientists to investigate scientific problems.
Choose the most appropriate format for presenting data, and process data using mathematical techniques such as statistical methods or calculating the gradients of graphs.	Identify complex relationships between variables, including inverse relationships, using several mathematical steps.
Determine the level of confidence for a conclusion based on scientific evidence and describe how further predictions can lead to more evidence being obtained.	Use range bars and understand their significance for data sets.
	Identify and critically analyse conflicting evidence, or weaknesses in the data, which lead to different interpretations, and explain what further data would help to make the conclusion more secure.

3.4 Module B1: Understanding Organisms

Module B1: Understanding Organisms

Item B1a: Fitness and health

Summary: This item looks at the differences between health and fitness, concentrating on the causes and prevention of heart disease, which is the most common cause of death in the UK.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Measure blood pressure.	Explain why blood in arteries is under pressure: • due to contraction of heart muscles • so that it reaches all parts of the body.
Visit a fitness centre, or have a visit from a representative and prepare a report on an individual fitness programme, including how ICT is used in assessing and monitoring fitness.	
Use websites to plan for a lower cholesterol intake. Produce a poster or leaflet encouraging a healthy lifestyle to reduce the risk of heart disease.	Recognise that the risk of developing heart disease can be increased by a number of factors, to include: • high blood pressure • smoking • eating high levels of salt • eating high levels of saturated fat. Describe how cholesterol can restrict or block blood flow in arteries by forming plaques. Analyse data that show the changing incidence of heart disease in the UK.

Module B1: Understanding Organisms

Item B1a: Fitness and health

Links to other items: B1b: Human health and diet, B1e: Drugs and you

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that blood pressure measurements consist of diastolic and systolic data in mmHg. Describe the factors that increase blood pressure: • being overweight • stress • high alcohol intake • smoking. Describe the factors that decrease blood pressure: • regular exercise • balanced diet.	Explain the possible consequences of having high blood pressure. Explain the possible consequences of having low blood pressure.
Explain the difference between fitness (the ability to do physical activity) and health (free from disease). Analyse the results of different ways of measuring fitness (strength, stamina, flexibility, agility, speed and cardiovascular efficiency).	Evaluate different ways of measuring fitness.
Explain how smoking increases blood pressure: • carbon monoxide reduces the oxygen-carrying capacity of the blood so heart rate increases to compensate • nicotine increases heart rate. Explain how diet can increase the risk of heart disease, to include: • saturated fats leading to a build up of cholesterol (a plaque) in arteries • high levels of salt elevating blood pressure. Interpret data showing possible links between the amount of saturated fat eaten, the build up of cholesterol plaques and the incidence of heart disease.	Explain why carbon monoxide reduces the carrying capacity of red blood cells, using the idea that it combines with the haemoglobin preventing the oxygen transport. Explain how narrowed coronary arteries, together with a thrombosis, increase the risk of a heart attack.

Module B1: Understanding Organisms

Item B1b: Human health and diet

Summary: The populations of many countries are either underweight and starving or obese with associated health problems. This item looks at food as a source of energy and raw materials and considers the effects of diet on candidates' bodies. This item provides the opportunity to collect and analyse scientific data from primary and secondary sources, including the use of ICT tasks, when investigating individuals' energy intake and countries facing food emergencies. Research on countries having food emergencies provides the opportunity to discuss ethical issues raised by science and technology.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Compare the nutritional value of various breakfast cereals. Record a day's food intake and calculate the total energy intake. Investigate energy content in various foods. Carry out simple food tests on a variety of food types.	Explain why a balanced diet should include: • protein • carbohydrates and fats • minerals (limited to iron) • vitamins (limited to vitamin C) • fibre • water.
Use ICT tasks, including video clips, to research countries having food emergencies and facing starvation. Calculate personal estimated average daily requirement (EAR) for protein. Record a day's food intake and calculate the amount of protein. Calculate a Body Mass Index (BMI) and use provided information to make a decision as to what it indicates.	Interpret simple data on diet. Explain why: • a high protein diet is necessary for teenagers • in many parts of the world diets are deficient in protein. Recall that proteins are only used as an energy source when fats or carbohydrates are unavailable. Recall that being very overweight (obese) is linked to increased health risks, to include arthritis, heart disease, diabetes and breast cancer.

Module B1: Understanding Organisms

Item B1b: Human health and diet

Links to other items: B1a: Fitness and health, B1e: Drugs and you

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that: • carbohydrates are made up of simple sugars such as glucose • fats are made up of fatty acids and glycerol • proteins are made up of amino acids. Explain how a balanced diet will vary depending on age, gender, activity, religion, personal choice (to include vegetarians and vegans) and medical issues (to include food allergies).	Describe the storage of biological molecules, to include: • carbohydrates are stored in the liver as glycogen or converted to fats • fats are stored under the skin and around organs as adipose tissue • proteins are not stored.
Explain why protein deficiency (kwashiorkor) is common in developing countries, limited to: • overpopulation • limited investment in agricultural techniques. Calculate the estimated average daily requirement (EAR) for protein using the formula: EAR in g = 0.6 × body mass in kg Calculate the Body Mass Index given the formula: BMI = mass in kg/(height in m)^2 and use it as a guide to understand the terms underweight, normal, overweight and obese. Explain how low self-esteem, poor self-image and desire for perfection can lead to a poor diet and the increased risks involved.	Explain why vegetarians need to eat proteins from a wide range of sources compared to people who eat proteins of animal origin. Understand that the EAR is an estimated daily figure for an average person of a certain body mass. Explain why the EAR for protein may vary depending on age, pregnancy and lactation.

Module B1: Understanding Organisms

Item B1c: Staying healthy

Summary: This item aims to help candidates understand the causes, preventative measures and cures of some diseases, while understanding that not all diseases are easily controlled or cured. This item provides the opportunity to analyse, interpret, apply and question scientific information and ideas, including some questions that science cannot currently answer in cancer treatment and drug testing. These topics also allow candidates to discuss ethical issues raised and develop the skills of scientific argument and presentation of data.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out a survey of diseases suffered by candidates in a class or year (limited to flu/colds, athlete's foot and 'stomach upsets') using primary or secondary sources. Case studies involving malaria.	Recall that infectious diseases are caused by pathogens (disease-causing microorganisms). Recall one example of a disease caused by each type of pathogen, limited to athlete's foot (fungi), flu (viruses), cholera (bacteria) and malaria (protozoa).
	Describe how the human body is defended against pathogens: • skin provides a barrier • blood clotting prevents entry of pathogens • pathogens are trapped by mucus in airways • hydrochloric acid in the stomach kills pathogens. Describe the difference between infectious and non-infectious diseases. Understand that some disorders have other causes, to include genetic causes.
Chart the immunisation programme recommended in the UK for children up to the age of 16. Carry out the role-playing exercise and data analysis from SATIS 9: The Chinese Cancer Detectives. Use a world map to plan holidays and estimate the risk of exposure to diseases such as malaria, cholera, hepatitis, polio and typhoid.	Recall that immunisation (vaccination) gives protection from certain pathogens. Describe how pathogens that enter the body are destroyed by the immune system (white blood cells): • engulfed by white blood cells • destroyed by antibodies. Interpret data on the incidence of disease around the world to show links with climate and socio-economic factors.
	Explain why new medical treatments/drugs are tested before use.

Module B1: Understanding Organisms

Item B1c: Staying healthy

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall the meaning of the terms parasite and host with reference to malaria. Describe how vectors spread disease: • limited to mosquito.	Explain how knowledge of the life cycle of a disease and the way in which vectors spread disease can help control infections: • limited to malaria and the mosquito.
Describe changes in lifestyle and diet which may reduce the risk of some cancers.	Describe the difference between benign and malignant tumours. Interpret data on types of cancer and survival/ mortality rates.
Explain how pathogens cause the symptoms of an infectious disease by cell damage or by production of toxins. Recall that antibodies lock on to antigens leading to the death of the pathogens. Explain the difference between passive (receive antibodies) and active immunity (make own antibodies). Recall the difference between antibiotics and antiviral drugs.	Explain how each pathogen has its own antigens so specific antibodies are needed. Explain the process of immunisation (vaccination): • harmless pathogen given which carries antigens • antigens trigger immune response by white blood cells which produce antibodies • immunity remains (memory cells produced). Describe the benefits and risks (possible side effects) associated with immunisation. Explain the need for careful use of antibiotics to prevent the increase of resistant strains such as MRSA.
Describe how new treatments are tested using animals, human tissue and computer models and understand objections to some forms of testing.	Explain why blind and double blind trials are used in testing new drugs against placebos or the best existing treatment.

Module B1: Understanding Organisms

Item B1d: The nervous system

Summary: Our bodies have to respond to changes that happen both inside and outside the body. The nervous system plays a major part in this. This item provides the opportunity to collect and analyse primary scientific data when investigating density of nerve endings in different skin areas and secondary data when researching reaction times in races. Theories and ideas can be tested in the investigation of binocular vision. This item develops safe and accurate work skills, along with analysis of ideas.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out an experiment to test ranges of vision using cardboard marked out in degrees or moving outstretched arms forward. Demonstrate binocular vision by bringing pencil points together at arm's length using one then two eyes.	Describe how animals detect changes in their environment (stimuli) using receptors which generate nerve impulses. Name and locate the main parts of the eye: cornea, iris, pupil, lens, retina, optic nerve and blind spot.
Investigate why some animals have binocular vision and others do not.	Explain the advantages and disadvantages of: • monocular vision: wider field of view but poorer judgement of distance • binocular vision: narrower field of view but better judgement of distance.
Carry out a survey on eye defects (candidates wearing glasses/contact lens) or use second hand data, in class or year group. Use colour vision deficiency charts.	Describe the main problems in vision limited to long-sight, short-sight and red-green colour blindness.
Carry out an experiment using blunt needles or forceps to determine the density of nerve endings in different skin areas. Carry out experiments on reaction times using ICT. Research allowable reaction times in races.	Name and locate the main parts of the nervous system, to include: • the central nervous system (CNS) (brain and spinal cord) • the peripheral nervous system. Describe the nerve impulse as an electrical signal that is carried by nerve cells called neurones. Describe reflex actions as fast, automatic and protective responses. Recognise that voluntary responses are under the conscious control of the brain.

Module B1: Understanding Organisms

Item B1d: The nervous system

Links to other items: B1e: Drugs and you, B1g: Controlling plant growth, B2e: Adaptations

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the functions of the main parts of the eye: • cornea - refracts light • iris - controls how much light enters pupil • lens - focuses light on to retina • retina - contains light receptors, some sensitive to light of different colours • optic nerve - carries impulses to the brain. Describe the pathway of light through the eyeball, being refracted by the cornea and lens and brought to focus on the retina.	Explain how the eye focuses light (accommodation) from near and distant objects.
Explain how binocular vision helps to judge distances by comparing the images from each eye - the more similar the images, the further away the object.	
Explain how long and short-sight is caused by the eyeball or the lens being the wrong shape. Explain a cause of red-green colour blindness as the lack of specialised cells in the retina.	Explain how long and short-sight can be corrected by corneal surgery or by different lenses in glasses or contact lenses.
Name and locate the parts of a motor neurone: cell body, axon and sheath. Recall that the nerve impulse passes along the axon of a neurone. Describe a reflex arc: stimulus → receptor → sensory neurone → central nervous system → motor neurone → effector → response. Describe the path taken by a spinal reflex involving a receptor, sensory neurone, relay neurone, motor neurone and effector.	Explain how neurones are adapted to their function by their length, insulating sheath and branched endings (dendrites). Recall that the gap between neurones is called a synapse. Describe how an impulse triggers the release of a transmitter substance in a synapse and how it diffuses across to bind with receptor molecules in the membrane of the next neurone causing the impulse to continue.

Module B1: Understanding Organisms

Item B1e: Drugs and you

Summary: Candidates are exposed to many influences that encourage their natural urge to experiment. This item considers the scientific knowledge and explanations of drugs, their effects and the risks involved. Many drugs are also used legitimately and some of these are considered. This item provides the opportunity to find out about the use of contemporary scientific and technological developments in the detection and analysis of different drugs used in sport. Data from secondary sources can be collected and analysed using ICT tools. There is the opportunity to discuss how scientific knowledge and ideas change over time when investigating the link between smoking and lung cancer.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Arrange a visit from the relevant police departments or rehabilitation centres.	Recognise that drugs can be beneficial or harmful. Explain why some drugs are only available on prescription. Explain the terms: addiction, withdrawal symptoms, tolerance and rehabilitation.
Research the drug testing programmes in sport. Research and present information about the effects of different drugs on the body.	Describe the general effects of each drug category: • depressants: slow down brain's activity • pain killers: block nerve impulses • stimulants: increase brain's activity • performance enhancers: muscle development • hallucinogens: distort what is seen and heard.
Carry out the smoking machine experiment to compare high, medium and low tar brands. Research a time line of the link between smoking and lung cancer. Discuss the current anti-smoking laws.	Recall that tobacco smoking can cause emphysema, bronchitis, cancer (mouth, throat, oesophagus and lung) and heart disease. Describe the effects of: • carbon monoxide (lack of oxygen, heart disease) • nicotine (addictive) • tars (irritant, carcinogenic) • particulates (accumulation in lung tissue).
Produce a poster to warn drivers about the dangers of drink driving.	Recognise the short term and long term effects of alcohol on the body: • short term (impaired judgment, balance and muscle control, blurred vision, slurred speech, drowsiness and increased blood flow to the skin) • long term effects (liver and brain damage). Explain why there is a legal limit for the level of alcohol in the blood/breath for drivers and pilots.

Module B1: Understanding Organisms

Item B1e: Drugs and you

Links to other items: B1a: Fitness and health, B1b: Human health and diet, B1d: The nervous system

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the basis of the legal classification of drugs: • Class A being the most dangerous with the heaviest penalties • Class C being the least dangerous with the lightest penalties.	
Recall examples of drugs: • depressants, limited to alcohol, solvents and temazepam • pain killers, limited to aspirin and paracetamol • stimulants, limited to nicotine, ecstasy and caffeine • performance enhancers, limited to anabolic steroids • hallucinogens, limited to LSD.	Explain the action of depressants and stimulants on the synapses of the nervous system: • depressants bind with receptor molecules in the membrane of the next neurone blocking the transmission of the impulses • stimulants cause more neurotransmitter to cross the synapse.
Describe how cigarette smoke affects ciliated epithelial cells lining the trachea, bronchi and bronchioles. Explain why damage to ciliated epithelial cells can lead to a 'smokers cough'.	Evaluate data on the effects of smoking in populations (to include cancer, heart disease, emphysema and birth weights of babies born to mothers who smoke).
Interpret data on the alcohol content (measured in units of alcohol) of different alcoholic drinks. Interpret information on reaction times, accident statistics and alcohol levels.	Describe how the liver can become damaged as it removes alcohol (cirrhosis), to include: • enzymes in liver breakdown alcohol • toxic products of alcohol breakdown cause liver damage.

Module B1: Understanding Organisms

Item B1f: Staying in balance

Summary: Many complex chemical processes take place in our cells and organs to ensure an optimum state. This item looks at how a constant internal environment is achieved. This item provides the opportunity to collect and analyse primary data and present information using scientific and mathematical conventions in the 'changing skin temperatures' experiment. The use of a data logger can provide an opportunity to use an ICT tool. Discussing the use of thermal blankets as a contemporary application of science, along with work on heat stroke, provides the opportunity to look at the benefits of technological developments.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Discuss automatic control systems in candidates' lives e.g. central heating, air conditioning, cruise control in cars, incubators.	Recognise that the body works to maintain steady levels of temperature, water, and carbon dioxide and that this is essential to life.
Carry out an experiment on the changing skin temperature down an arm or a leg and plot the results accurately on a graph. Measure body temperature using a range of different procedures. Discuss the use of thermal first aid blankets after activities such as marathons. Produce a poster warning older people about hypothermia and telling them how to prevent it.	Recall that the core temperature of the human body is normally maintained at approximately 37°C. Describe appropriate procedures to measure body temperature: • where (ear, finger, mouth, or anus) • how (using a clinical thermometer, sensitive strips, digital recording probes, or thermal imaging). Describe how heat can be gained or retained (by respiration, shivering, exercise, less sweating, less blood flow near skin surface, or clothing). Describe how more heat can be lost (by sweating, or more blood flow near skin).
Research diabetes and how it can be managed. www.abpischools.org.uk	Name and locate the pancreas. Recall that the pancreas produces the hormone insulin. Recall that Type 1 diabetes is caused by the failure of the pancreas to produce insulin. Describe how insulin travels around the body.

Module B1: Understanding Organisms

Item B1f: Staying in balance

Links to other items: B2e: Adaptations

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand that maintaining a constant internal environment involves balancing bodily inputs and outputs and is called homeostasis. Explain why factors are kept at steady levels by automatic control systems (limited to temperature, water content and carbon dioxide).	Explain how negative feedback mechanisms are used to maintain a constant internal environment.
Explain how sweating increases heat transfer to the environment by evaporation of sweat which requires heat, so removing heat from the skin. Understand that the body temperature of 37 °C is the optimum temperature for the action of many enzymes. Describe how high temperatures can cause heat stroke and dehydration and if untreated, death. Describe how very low temperatures can cause hypothermia and if untreated, death.	Explain how vasodilation and vasoconstriction increase or reduce heat transfer to the environment. Understand that the body temperature of 37°C is linked to enzyme action. Explain how blood temperature is monitored by the brain which will bring about temperature control mechanisms via the nervous and hormonal systems.
Recall that insulin controls blood sugar levels. Explain how Type 2 diabetes can often be controlled by diet but that Type 1 diabetes also needs to be treated by insulin dosage. Explain why responses controlled by hormones are usually slower than responses controlled by the nervous system.	Explain how insulin helps to regulate blood sugar levels. Explain how the dosage of insulin needed to be taken by a person with Type 1 diabetes depends upon diet and activity.

Module B1: Understanding Organisms

Item B1g: Controlling plant growth

Summary: Growth and development in plants are controlled by plant growth regulators (hormones). This item examines some examples of this, as well as how humans can use plant hormones to aid the efficient production of food. Experiments on seed growth allow the development of safe and accurate working, the presenting of results and evaluation of data collection and the quality of the data.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out an experiment to test whether cress seedlings grow towards light. Carry out an experiment to test whether bean roots always grow downwards. Use ICT to watch and compare time lapse videos of plant tropisms.	Recognise that plants as well as animals respond to changes in their environment. Understand that plant growth (limited to growth of shoots and roots, flowering and fruit ripening) is controlled by chemicals called plant hormones. Describe an experiment to show that shoots grow towards light. Understand how growth towards light increases the plant's chance of survival. Understand why roots grow downwards.
Take cuttings using rooting powder to encourage root growth. Research how seedless grapes are produced. Investigate bananas ripening more quickly if already-ripened bananas are close by; research why this happens.	Recognise that plant hormones can be used in agriculture to speed up or slow down plant growth.

Module B1: Understanding Organisms

Item B1g: Controlling plant growth

Links to other items: B1d: The nervous system

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe shoots as positively phototropic but negatively geotropic. Describe roots as negatively phototropic but positively geotropic. Recall that the group of plant hormones called auxins: • move through the plant in solution • are involved in the response to light (phototropism) • are involved in the response to gravity (geotropism).	Interpret data from phototropism experiments in terms of auxin action: • auxin made in tip • unequally distributed in response to light. Explain how auxin brings about shoot curvature in terms of cell elongation.
Relate the action of plant hormones to their commercial uses: • selective weedkillers • rooting powder • fruit ripening (delay or acceleration) • control of dormancy.	

Module B1: Understanding Organisms

Item B1h: Variation and inheritance

Summary: This item looks at the causes of variation and how we can use our knowledge of inheritance to help predict the characteristics of children.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Use poppit beads to show combinations due to chance. Toss coins to show expected and 'real' ratios. Use a genetics kit to show the results of a monohybrid cross. Debate the arguments for and against parents knowing a baby's gender before birth.	Analyse human characteristics to determine those that are a result of both environmental and inherited factors, to include: • intelligence • body mass • height. Recall that chromosomes are held in the nucleus and that they carry information in the form of genes, which control inherited characteristics. Recognise that most body cells contain chromosomes in matched pairs. Recall that gametes have half the number of chromosomes of body cells.
	Recognise that some disorders are inherited: red-green colour blindness, sickle cell anaemia and cystic fibrosis.

Module B1: Understanding Organisms

Item B1h: Variation and inheritance

Links to other items: B2a: Classification, B2f: Natural selection

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Identify inherited characteristics as dominant or recessive when given the results of a breeding experiment. Explain the causes of genetic variation, to include: • mutations (changes to the genes) • gamete formation • fertilisation. Recall that most body cells have the same number of chromosomes but this number varies between species (humans have 23 pairs). Recall that alleles are different versions of the same gene. Describe how sex in mammals is determined by sex chromosomes: XX (female) and XY (male).	Understand the debate over the relative importance of genetic and environmental factors in determining some human attributes: intelligence, sporting ability and health. Explain how dominant and recessive characteristics depend on dominant and recessive alleles: • dominant alleles are those expressed if present • recessive alleles are those only expressed if the dominant allele is absent. Explain a monohybrid cross involving dominant and recessive alleles using genetic diagrams with letters representing alleles. Use and explain genetic terms: • homozygous – two identical alleles • heterozygous – two different alleles • genotype – the genetic makeup • phenotype – the characteristics expressed. Explain sex inheritance, including the production of equal numbers of male and female offspring, using genetic diagrams.
Understand that inherited disorders are caused by faulty genes. Understand the issues raised by knowledge of inherited disorders in a family.	Recall that inherited disorders are caused by faulty alleles, most of which are recessive. Use genetic diagrams to predict the probabilities of inherited disorders passing to the next generation.

3.5 Module C1: Carbon Chemistry

Module C1: Carbon Chemistry

Item C1: 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 practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
These learning outcomes are intended to be taught throughout this specification.	Understand that in a chemical reaction reactants are changed into products. Recognise the reactants and products in a word equation. Construct word equations given the reactants and products.
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.	Deduce the number of elements in a compound given its formula. Deduce the number of atoms in a formula with no brackets. Deduce 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. Deduce the names of the different elements in a compound given its formula.
These learning outcomes are intended to be taught throughout this specification.	Understand that a molecule is made up of more than one atom joined together. Understand that a molecular formula shows the numbers and types of atom in a molecule. Deduce the number of atoms in a displayed formula. Deduce the names of the different elements in a compound given its displayed formula. Deduce the number of each different type of atom in a displayed formula.
These learning outcomes are intended to be taught throughout this specification.	Recognise whether a particle is an atom, molecule or ion given its formula. Understand that atoms contain smaller particles one of which is a negative electron.
These learning outcomes are intended to be taught throughout this specification.	Recall that two types of chemical bond holding atoms together are: • ionic bonds • covalent bonds.

Module C1: Carbon Chemistry

Item C1: Fundamental Chemical Concepts

Links to other items: C1 to C6

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Construct word equations (not all reactants and products given).	
Construct balanced symbol equations given the formulae (no brackets) of the reactants and products. Explain why a symbol equation is balanced.	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 C1).
Deduce the number of atoms in a formula with brackets. Deduce 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 • oxygen and water.	Recall the formula of the following substances: • sulfuric acid • sulfur dioxide • sodium hydrogencarbonate and sodium carbonate.
Understand 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.	Construct balanced equations using displayed formulae.
Understand that positive ions are formed when electrons are lost from atoms. Understand that negative ions are formed when electrons are gained by atoms.	
Understand that an ionic bond is the attraction between a positive ion and a negative ion. Understand that a covalent bond is a shared pair of electrons.	Explain how an ionic bond is formed. Explain how a covalent bond is formed.

Module C1: Carbon Chemistry

Item C1a: 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. It also demonstrates the importance of timescale with reference to non-renewable 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 practical and research activities 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.	Recall 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. Research the different products that can be made from crude oil.	Recognise that fractional distillation separates crude oil into useful products called fractions. Understand that fractional distillation works because of differences in boiling points. Recognise that LPG, petrol, diesel, paraffin, heating oil, fuel oils and bitumen are fractions obtained from crude oil. Recall that LPG contains propane and butane gases.
Research the problems of oil exploitation and possible solutions.	Describe some of the environmental problems involved in the exploitation of crude oil: • oil slicks as a result of accidents • 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.

Module C1: Carbon Chemistry

Item C1a: Making crude oil useful

Links to other items: C1b: Using carbon fuels, C1d: Polymers, C1e: Designer polymers

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: • finite resources are no longer being made or being made extremely slowly • non-renewable resources are used up faster than they are formed. Describe crude oil as a mixture of many hydrocarbons.	Discuss the problems associated with the finite nature of crude oil: • all the readily extractable resources will be used up in the future • finding replacements • conflict between making petrochemicals and fuels.
Label a diagram of a crude oil fractional distillation column to show the main fractions and the temperature gradient. Describe how fractional distillation separates 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 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 in terms of molecular size, intermolecular forces and boiling point why crude oil can be separated by fractional distillation. Understand that during boiling the intermolecular forces between molecules break but covalent bonds within the molecule do not.
Explain some of the potential environmental problems involved in the transportation of crude oil: • damage to birds' feathers causing death • use of detergents to clean up oil slicks and consequent damage to wildlife.	Explain in simple terms the political problems associated with the exploitation of crude oil: • UK dependent on oil and gas from politically unstable countries • future supply issues.
Describe cracking as a process that: • converts large alkane molecules into smaller alkane and alkene molecules • makes useful alkene molecules that 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 C1b: 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 and how and why decisions about science and technology are made.

Suggested practical and research activities 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 simple data about fuels in order to choose the best fuel for a particular purpose (no recall expected). List the factors about fuels in order to choose the best fuel for a particular purpose: • energy value • availability • storage • cost • toxicity • pollution e.g. acid rain, greenhouse effect • ease of use.
Carry out an experiment to show that combustion of a hydrocarbon in a plentiful supply of air produces carbon dioxide and water.	Recall that the combustion of a fuel releases useful heat energy. Understand why complete combustion needs a plentiful supply of oxygen (air). Recall that complete combustion of a hydrocarbon fuel makes only carbon dioxide and water. Construct word equations to show the complete combustion of a hydrocarbon fuel given the reactants and products.
Design a poster warning about the dangers of carbon monoxide poisoning e.g. using appropriate ICT software. Investigate the products of complete and incomplete combustion by experiment.	Understand why incomplete combustion takes place. Explain why a blue Bunsen flame releases more energy than a yellow flame. Identify that a yellow flame produces lots of soot. Recall that incomplete combustion of a hydrocarbon fuel makes carbon monoxide, carbon (soot) and water. Recall that carbon monoxide is a poisonous gas. Construct word equations to show the incomplete combustion of a hydrocarbon fuel given the reactants and products.

Module C1: Carbon Chemistry

Item C1b: Using carbon fuels

Links to other items: C1a: Making crude oil useful, C1c: Clean air, C1d: Making polymers

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Interpret data fuels in order to choose the best fuel for a particular purpose (no recall expected). Suggest the key factors that need to be considered when choosing a fuel for a particular purpose.	Evaluate the use (no recall expected) of different fuels. Explain why the amount of fossil fuels being burnt is increasing: • increasing world population • growth of use in developing countries e.g. India and China.
Describe an experiment to show that combustion of a hydrocarbon in a plentiful supply of air produces carbon dioxide and water. Construct word equations to show the complete combustion of a hydrocarbon fuel (not all reactants and products given).	Construct the balanced symbol equation for the complete combustion of a simple hydrocarbon fuel given its molecular formula.
Explain the advantages of complete combustion over incomplete combustion of hydrocarbon fuels. Construct word equations to show the incomplete combustion of a hydrocarbon fuel (not all reactants and products given).	Construct the balanced symbol equation for the incomplete combustion of a simple hydrocarbon fuel given its molecular formula and the product (carbon or carbon monoxide).

Module C1: Carbon Chemistry

Item C1c: 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 and how it can be prevented. The use of catalytic converters to reduce atmospheric pollution is also considered. The evolution of the atmosphere including the timescales involved and the ethical issues around human influences on the atmosphere are also introduced.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Experimental determination of the composition of clean air. Produce some research or a poster to show the main processes in the carbon cycle. Produce a time line showing the sequence of events in the evolution of the atmosphere.	Recall that air contains oxygen, nitrogen, water vapour and carbon dioxide. Understand how photosynthesis, respiration and combustion affect the level of carbon dioxide and the level of oxygen in the air. Understand that oxygen, nitrogen and carbon dioxide levels in the present day atmosphere are approximately constant.
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 and/or to the source of the pollutant: • carbon monoxide – a poisonous gas formed by the incomplete combustion of petrol or diesel in car engines • oxides of nitrogen – causes photochemical smog and acid rain and are formed in the internal combustion engine • sulfur dioxide – causes acid rain that will kill plants, kill aquatic life, erode stonework and corrode metals and is formed when sulfur impurities in fossil fuels burn.
Research the methods of preventing atmospheric pollution.	Recall that a catalytic converter removes carbon monoxide from the exhaust gases of a car.

Module C1: Carbon Chemistry

Item C1c: Clean air

Links to other items: C1b: Using carbon fuels

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall 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 increased the percentage of oxygen until it reached today's level.	Evaluate the effects of human influences on the composition of air, for example: • deforestation • population. Describe one possible theory for how the present day atmosphere evolved over millions of years (based on the composition of gases vented by present day volcanic activity): • degassing of early volcanoes producing an atmosphere rich in water and carbon dioxide • condensing of water vapour to form oceans • dissolving of carbon dioxide in ocean waters • relative increase of nitrogen due to its lack of reactivity • development of photosynthetic organisms • increase in oxygen levels due to photosynthesis.
Interpret data about the effects of atmospheric pollutants.	Explain why the high temperature inside an internal combustion engine allows nitrogen from the air to react with oxygen to make oxides of nitrogen.
Explain why it is important that atmospheric pollution is controlled. Understand that a catalytic converter changes carbon monoxide into carbon dioxide.	Explain how use of a catalytic converter removes carbon monoxide from exhaust fumes using the balanced symbol equation: $2CO + 2NO \rightarrow N_2 + 2CO_2$

Module C1: Carbon Chemistry

Item C1d: 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 practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Use of molecular models. Use of ICT to show shapes of molecules.	Recall 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.	Recognise that alkanes are hydrocarbons.
Test for unsaturation using bromine water.	Recognise that alkenes are hydrocarbons.
Card game: matching monomers and polymers. Use of molecular models. Making 'polypaperclips'.	Deduce 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). Demonstration – making poly(phenylethene) – details from RSC website www.practicalchemistry.org. PVA polymer slime details from RSC website www.practicalchemistry.org.	Recall that large molecules, called polymers are made when many small molecules, called monomers, join together in a polymerisation reaction.

Module C1: Carbon Chemistry

Item C1d: Making polymers

Links to other items: C1a: Making crude oil useful, C1b: Using carbon fuels, C1e: Designer polymers

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that a hydrocarbon is a compound formed between carbon atoms and hydrogen atoms only. Given the molecular or displayed formula of a compound, explain why it is a hydrocarbon.	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.
Recall that alkanes are hydrocarbons which contain single covalent bonds only. Interpret information on displayed formulae of alkanes.	Interpret information from the displayed formula of a saturated hydrocarbon.
Recall that alkenes are hydrocarbons which contain a double covalent bond(s) between carbon atoms. Understand that double bonds involve two shared pairs of electrons. Interpret information on displayed formulae of alkenes. Describe how the reaction with bromine can be used to test for an alkene: • bromine water is orange • bromine water is decolourised.	Interpret information from the displayed formula of an unsaturated hydrocarbon. Explain the reaction between bromine and alkenes: • addition reaction • formation of a colourless dibromo compound.
Recognise the displayed formula for a polymer.	Draw the displayed formula of an addition polymer given the displayed formula of its monomer. Draw the displayed formula of a monomer given the displayed formula of its addition polymer.
Describe addition polymerisation as a process in which many alkene monomer molecules react together to give a polymer which requires high pressure and a catalyst.	Explain addition polymerisation in terms of addition of unsaturated molecules.

Module C1: Carbon Chemistry

Item C1e: 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 in the 21st century, including health care. Issues of disposal of polymers are also considered.

Suggested practical and research activities 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. Identification of polymers (plastics).	Recall that nylon is used in clothing.
Research how local councils dispose of public waste.	Understand that many polymers are non-biodegradable and so will not decay or decompose by bacterial action. Recall some of the ways that waste polymers can be disposed of: • use of land-fill sites • burning of waste polymers • recycling.

Module C1: Carbon Chemistry

Item C1e: Designer polymers

Links to other items: C1a: Making crude oil useful, C1d: 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.	Understand 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® fabric: • nylon is tough, lightweight, keeps water out and keeps UV light out but does not let water vapour through it which means that sweat condenses • GORE-TEX® fabric has all of the properties of nylon but is also breathable. Explain why the discovery of GORE-TEX® fabric type materials has been of great help to active outdoor people to cope with perspiration wetness.	Explain why GORE-TEX® fabric type materials are waterproof and yet breathable: • nylon laminated with PTFE / polyurethane membrane • holes in membrane are too small for water to pass through but are big enough for water vapour to pass through • membrane is too fragile on its own and so is combined with nylon.
Explain why chemists are developing new types of polymers: • polymers that dissolve • biodegradable polymers. Explain environmental and economic issues related to the use and disposal of polymers.	

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Module C1: Carbon Chemistry

Item C1f: Cooking and food additives

Summary: Cooking involves chemical reactions in food to develop a different texture and taste. This item considers the chemical changes that happen to some foods when they are cooked. Much of the food eaten today contains food additives to colour food, enhance the flavour, add vitamins, stabilise the food, or stop it decaying. This item considers different types of food additive and some of the issues concerned with their use. This item provides the opportunity to collect and analyse secondary data using ICT tools when researching food additives and provides opportunities for interpreting and applying science ideas.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate the effect of heating on proteins such as those in eggs or meat. Investigate the effect of heat on potatoes. RSC material at www.practicalchemistry.org/experiments/structure-and-bonding.	Recognise that a chemical change takes place if: • there is a new substance made • the process is irreversible • an energy change takes place. Explain why cooking food is a chemical change: • a new substance is formed • the process cannot be reversed.
Data search into the types of food additive e.g. using suitable web sites. Look at food labels for additives. Discuss the advantages and disadvantages of using food additives. Investigate emulsifiers by mixing oil and water. Test a range of common substances to see which act as emulsifiers.	Relate types of food additive to their function: • antioxidants stop foods from reacting with oxygen • food colours give food an improved colour • flavour enhancers improve the flavour of a food • emulsifiers help oil and water to mix and not separate.
Investigate the action of heat on baking powder.	Explain how baking powder helps make cakes rise. Recall that the chemical test for carbon dioxide is that it turns lime water cloudy.

Module C1: Carbon Chemistry

Item C1f: Cooking and food additives

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that protein molecules in eggs and meat change shape when eggs and meat are cooked: this is called denaturing.	Explain why the texture of egg or meat changes when it is cooked: • shape of protein molecules permanently changes. Explain why potato is easier to digest if it is cooked: • cell walls rupture resulting in loss of rigid structure and a softer texture • starch grains swell up and spread out.
Describe emulsifiers as molecules that have a water loving (hydrophilic) part and an oil or fat loving (hydrophobic) part.	Explain why an emulsifier helps to keep oil and water from separating: • hydrophilic end bonds to water molecules • hydrophobic end bonds with oil or fat molecules.
Recall the word equation for the decomposition of sodium hydrogencarbonate (not all products given). sodium hydrogencarbonate → sodium carbonate + carbon dioxide + water Construct the balanced symbol equation for the decomposition of sodium hydrogencarbonate (some or all formulae given): $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$	Construct the balanced symbol equation for the decomposition of sodium hydrogencarbonate (formulae not given): $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$

Module C1: Carbon Chemistry

Item C1g: 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 practical and research activities 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 identification of the smells. Research the uses of esters.	Understand that cosmetics are either synthetic or natural depending on their source. Recall that esters are perfumes that can be made synthetically.
Research and display the properties of perfumes.	Recall the necessary physical properties of perfumes: • 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.	Understand that nail-varnish remover dissolves nail varnish colours. Understand the terms solvent, solute, solution, soluble and insoluble.
Debate: “Is testing of cosmetics on animals ever justified?”	Recall that testing of cosmetics on animals is banned in the EU. Explain why new cosmetic products need to be thoroughly tested before they are permitted to be used.

Module C1: Carbon Chemistry

Item C1g: Smells

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that alcohols react with acids to make an ester and water. Describe how to carry out a simple experiment to make an ester.	
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: • in order to evaporate, particles need sufficient energy to overcome the attraction to other molecules in the liquid • only weak attraction exists between particles in the liquid perfume so it is easy to overcome this attraction.
Recall that esters can be used as solvents. Describe a solution as 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 testing of cosmetics on animals has been banned in the EU.	Explain why people have different opinions about whether the testing of cosmetics on animals is ever justified.

Module C1: Carbon Chemistry

Item C1h: Paints and pigments

Summary: Pigments and paints play an important part in our modern 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 practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Making coloured substances by mixing together solutions. Data-search via internet about paints and the ingredients in paints. Make a simple paint.	Relate the ingredients of a paint to their function: • solvent thins the paint and makes it easier to spread • binding medium sticks the pigment in the paint to the surface • pigment is the substance that gives the paint its colour. Recall 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.	Explain why paint is used (in a given context).
Investigate thermochromic pigments using materials e.g. material from Middlesex University Teaching Resources. Demonstrate some objects that contain thermochromic pigments.	Recall that thermochromic pigments change colour when heated or cooled. Recall uses of thermochromic pigments.
Investigate phosphorescent pigments using material e.g. material from Middlesex University Teaching Resources.	Recall that phosphorescent pigments can glow in the dark.

Module C1: Carbon Chemistry

Item C1h: Paints and pigments

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 why the components of a colloid will not separate.
Describe how most paints dry: • paints are applied as a thin layer • the solvent evaporates. Describe emulsion paints as water based paints that dry when the solvent evaporates.	Explain how oil paints dry: • the solvent evaporates • the oil is oxidised by atmospheric oxygen.
Explain why thermochromic pigments are suited to a given use.	Explain how acrylic paints can be added to thermochromic pigments to make even more colour changes.
Explain why phosphorescent pigments glow in the dark: • they absorb and store energy • then release it as light over a period of time.	Recall that phosphorescent pigments are much safer than the alternative radioactive substances

3.6 Module P1: Energy For The Home

Module P1: Energy For The Home

Item P1a: Heating houses

Summary: When a body is heated, it gets hotter. A common misconception is that heat and temperature are the same thing. This item develops ideas to show that heat and temperature are different and that heat gain or loss does not always result in a temperature rise but can bring about a change of state. Because of a high specific heat capacity water needs lots of energy to increase its temperature. Because of this it also stores lots of energy and so is useful for transporting and transferring energy around homes.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out an experiment to measure the fall in temperature of hot water. Carry out an experiment to measure the increase in temperature of water as it is heated. Examine thermograms to see where hot spots occur.	Understand that for warm bodies the rate of cooling depends on the temperature difference compared to the surroundings. Understand that temperature is represented by colour in a thermogram.
Carry out an experiment to measure the energy required to change the temperature of different bodies by different amounts.	Recall that heat is a measurement of energy and is measured in Joules (J). Describe that the energy needed to change the temperature of a body depends on: • mass • the material from which it is made • the temperature change. Describe an experiment to measure the energy required to change the temperature of a body.
Show that energy is needed to change state by placing a small piece of chocolate on the tongue and allowing it to melt. Carry out an experiment holding a lump of ice to explain why the ice melts and why the hand holding it gets cold. Carry out an experiment or use a computer simulation to plot a cooling curve for stearic acid as it cools.	Interpret data which shows that there is no temperature change when materials are: • boiling • melting or freezing.

Module P1: Energy For The Home

Item P1a: Heating houses

Links to other items: P1b: Keeping homes warm

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recognise, and understand the consequences of, the direction of energy flow between bodies of different temperatures. Interpret data on rate of cooling. Explain how temperatures can be represented by a range of colours in a thermogram: • hottest parts: white/yellow/red • coldest parts: black/dark blue/purple.	Describe temperature as a measurement of hotness on an arbitrary or chosen scale. Understand that temperature is a measurement of the average kinetic energy of particles.
Understand qualitatively and quantitatively the concept of the specific heat capacity of a material. Use the equation: $\text{energy} = \text{mass} \times \frac{\text{specific heat}}{\text{capacity}} \times \frac{\text{temperature}}{\text{change}}$	Describe heat as a measurement of energy on an absolute scale. Use the equation, including a change of subject: $\text{energy} = \text{mass} \times \frac{\text{specific heat}}{\text{capacity}} \times \frac{\text{temperature}}{\text{change}}$ An initial calculation of temperature change may be required.
Understand qualitatively and quantitatively the concept of the specific latent heat of a material. Use the equation: energy = mass × specific latent heat Describe how, even though energy is still being transferred, there is no temperature change when materials are: • boiling • melting or freezing.	Use the equation, including a change of subject: energy = mass × specific latent heat Explain why the temperature does not change during a change of state.

Module P1: Energy For The Home

Item P1b: Keeping homes warm

Summary: The term insulation is used in the wider context of energy saving techniques in the home. This item develops ideas about the mechanisms of energy transfer by conduction, convection and radiation and the role they play in heat loss from homes. A poorly insulated home means that heat is being lost to the outside environment and more energy is needed to keep the home warm. Not only are energy resources being wasted but the homeowner is also paying for energy that is lost to the outside environment. This item develops ideas about using energy efficiently and reducing energy losses from homes.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Use a data logger or other apparatus to carry out an experiment to test the relative performance of various insulating materials. Use a data logger or other apparatus to carry out an experiment to test the transfer of energy through models (e.g. test tubes or beakers) of single, double and triple glazed windows. Use a data logger or other apparatus to carry out an experiment to test the reflection of energy from a silvered surface. Use a data logger or other apparatus to carry out an experiment to test the absorption of energy by a blackened dull surface. Perform or watch demonstration experiments to show convection currents in air and water.	Explain why trapped air in a material is a very good insulator. Recall that infrared radiation is: • reflected from a shiny surface • absorbed by a dull or rough surface. Understand how absorption and reflection of infrared radiation can be applied in everyday situations.
Examine thermograms showing where energy is lost from poorly insulated houses and from well insulated houses. Examine data showing percentage of energy lost from different areas of a poorly insulated house and from a well insulated house. Survey of fuel costs in the local area. Survey to compare the effectiveness of different building materials using information from the internet and builders' merchants. Use information, either in paper form or from websites including from local authorities and government, to compare costs of energy saving measures. Make a brochure or PowerPoint presentation to convince people to invest in energy saving measures.	Describe everyday examples of energy saving methods in the home. Explain how the property that air is a very good insulator is used to keep homes warm: • fibreglass, mineral or rock wool in loft insulation • double glazing in windows • insulation foam or fibreglass in cavity walls • curtains at windows. Describe other energy saving measures: • reflective foil in or on walls • draught-proofing. Use the equation: $\text{efficiency} = \frac{\text{useful energy output } (\times 100\%)}{\text{total energy input}}$ given the useful energy output and the total energy input; efficiency can be expressed in ratio or percentage terms.

Module P1: Energy For The Home

Item P1b: Keeping homes warm

Links to other items: P1a: Heating houses, P1c: A spectrum of waves

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how energy is transferred in terms of: • conduction • convection • radiation and how such losses can be reduced in homes by energy saving measures to include: • loft insulation • double glazing • cavity wall insulation. Understand and use the terms source and sink in context of energy lost from houses.	Describe how energy is transferred by: • conduction – transfer of KE between particles, to include the role played by free electrons • convection – how expansion when a liquid or gas is heated causes a change of density which results in (bulk) fluid flow • radiation – infrared radiation is an electromagnetic wave and needs no medium. Explain how there will be energy loss in a cavity wall and what further measures could be taken to limit this loss.
Interpret data for different energy saving strategies to include calculations involving: • initial cost • annual saving on energy bills • payback time. Use the equation: $\text{efficiency} = \frac{\text{useful energy output } (\times 100\%)}{\text{total energy input}}$ given the wasted energy and total energy input; efficiency can be expressed in ratio or percentage terms. Interpret and complete information presented in Sankey diagrams, to show understanding that energy is conserved.	Explain, in the context of the home, the concepts of conduction, convection and radiation (absorption and emission) in terms of: • the design features of the home • the design and use of everyday appliances in the home • energy saving strategies. Use the equation: $\text{efficiency} = \frac{\text{useful energy output } (\times 100\%)}{\text{total energy input}}$ to calculate the useful energy output, total energy input or wasted energy, which may be used to complete a Sankey diagram. Efficiency can be expressed in ratio or percentage terms.

Module P1: Energy For The Home

Item P1c: A spectrum of waves

Summary: Infrared radiation has been introduced in the context of heat transfer, but before further uses of electromagnetic (e-m) waves are considered, the properties of transverse waves are introduced. The electromagnetic spectrum is outlined, with a focus on the communication uses of non-ionising e-m waves. Some of the practical limitations of using waves are related to wavelength.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Looking at and measuring waves: • in ripple tanks • in PowerPoint simulations • using a CRO • using a 'slinky'.	Identify and name the main features of a transverse wave: • trough and crest • amplitude • wavelength.
	Recall that all electromagnetic waves travel at the same high speed in space or a vacuum. Use the equation: wave speed = frequency × wavelength.
Carry out raybox, mirror and prism experiments to demonstrate ray tracing techniques for reflection and refraction.	Recall that electromagnetic waves travel in straight lines through a particular medium. Use ray diagrams to describe reflection at single plane (flat) boundaries. Recognise that refraction involves a change in direction of a wave due to the wave passing from one medium into another.
Disperse white light with a prism. Recreate William Herschel's experiment to discover infrared radiation and its link to the visible spectrum. Sort and match activities to look at the properties and uses of the different parts of the electromagnetic spectrum.	Identify the seven types of electromagnetic waves that comprise the spectrum and place them in ascending order of frequency. Describe an example of a communications use for radio, microwave, infrared and visible light.

Module P1: Energy For The Home

Item P1c: A spectrum of waves

Links to other items: P1b: Keeping homes warm, P1d: Light and lasers, P1e: Cooking and communicating using waves, P1f: Data transmission, P1g: Wireless signals, P1h: Stable Earth, P2c: Global warming

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the main features of a transverse wave: • trough and crest • amplitude • wavelength • frequency – as the number of complete waves, cycles, or oscillations per second.	
Determine the value of the wavelength or the frequency of a wave from a diagram and be able to use the value in the equation: wave speed = frequency × wavelength	Use the equation including a change of subject and/or use of standard form (or the use of a scientific notation calculator): wave speed = frequency × wavelength
Use basic ray diagrams to demonstrate reflection at multiple plane (flat) boundaries. Understand why refraction occurs at the boundary between mediums. Describe diffraction of waves at an opening.	Describe a diffraction pattern for waves, including the significance of the size of the opening or barrier relative to the wavelength.
Identify the seven types of electromagnetic waves that comprise the spectrum and place them in order of frequency or wavelength. Relate the size of a communications receiver to the wavelength for radio, microwave, infrared and visible light.	Describe and explain the limiting effects of diffraction on wave based sensors, to include: • telescopes • optical microscopes.

Module P1: Energy For The Home

Item P1d: Light and lasers

Summary: The use of light as a source of digital communication, from Morse signalling to present day laser technology, has made rapid communication possible. This item develops ideas about communication at the speed of light, including applications of Total Internal Reflection.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Show that a message can be transmitted using a signal lamp. Relate the flashing signal light messages to the use of Morse code.	Describe how, historically, the use of light greatly increased the speed of communication but that it requires the use of a code.
Carry out an experiment to measure the critical angle for perspex or glass. Show that lengths of optical fibre and a pencil torch can make a model of a fibre optic lamp. Show that infrared radiation can be transmitted along a length of optical fibre. Show that optical fibres can transmit a signal from tape recorder or CD player to an amplifier (and loudspeaker) or send a program from one computer to another.	Recognise, in the context of optical fibres, where Total Internal Reflection (TIR) happens: • glass-air boundary • water-air boundary • perspex-air boundary. Understand how light and infrared radiation can travel along an optical fibre from one end to another by reflection from the sides of the fibre.
Examine the surface of a CD under a laboratory microscope and then look at images from the internet or other resource showing 10 000 × magnification.	Understand how the properties of light produced by lasers allows them to be used for: • surgery and dental treatment • cutting materials in industry • weapon guidance • laser light shows.

Module P1: Energy For The Home

Item P1d: Light and lasers

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how light was used as a means of communication: • signals sent in the form of Morse code which is a series of on off signals • signals relayed between stations to cover larger distances. Describe why Morse code is a digital signal.	Explain the advantages and disadvantages of using light, radio and electrical signals for communication.
Describe what happens to light incident on a boundary, e.g. glass-air, water-air or perspex-air boundary, below, at and above the critical angle. Understand how transfer of light along an optical fibre depends on the critical angle of the incident light.	Describe applications of Total Internal Reflection (TIR) in fibre optics.
Recall that a laser produces a narrow beam of light of a single colour (monochromatic).	Explain why most lasers produce an intense coherent beam of light: • waves have the same frequency • waves are in phase with each other • waves have low divergence. Explain how a laser beam is used in a CD player by reflection from the shiny surface: • information is stored on the bottom surface • information is stored digitally • information in the form of patterns of bumps (known as pits) • a CD will contain billions of pits.

Module P1: Energy For The Home

Item P1e: Cooking and communicating using waves

Summary: All radiations in the electromagnetic spectrum can be dangerous but they also have many uses. Infrared radiation and microwaves are useful for cooking since they cause heating in objects that absorb them. Microwaves are used for mobile phone communications. This item develops ideas about the properties of infrared and microwave radiation and examines their dangers and uses.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine household objects that work by infrared radiation: • radiator (does not glow red) • toaster (does glow red) • remote controls use a fine beam of infrared radiation. Carry out an experiment to measure the temperature increase near an object emitting infrared radiation.	Interpret information on the electromagnetic spectrum to include microwaves and infrared radiation. Understand how the emission and absorption of infrared radiation is affected by the properties of the surface of an object. Properties to include: • surface (temperature) • colour (black or white) • texture (shiny or dull). Recognise that microwaves cause heating when absorbed by water or fat and that this is the basis of microwave cooking.
Carry out an experiment to show that older mobile phones or a microwave oven in use emit radiation that causes interference with a radio signal.	Recall that mobile phones use microwave signals.
Interpret information about the use and safety of mobile phone technology, e.g. using internet search. Survey opinions about the positioning of mobile phone masts. Research the evidence for and against the possible damage to humans when using mobile phones and present the findings in the form of a leaflet.	Describe some concerns about children using mobile phones. Recall that different studies into the effects of mobile phone use have reached conflicting conclusions.

Module P1: Energy For The Home

Item P1e: Cooking and communicating using waves

Links to other items: C1f: Cooking and food additives, P1b: Keeping homes warm, P1c: A spectrum of waves, P1f: Data transmission, P1g: Wireless signals

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe properties of infrared radiation: • heats the surface of the food • is reflected by shiny surfaces. Describe properties of microwaves: • penetrate (about 1cm) into food • are reflected by shiny metal surfaces • can cause burns when absorbed by body tissue • pass through glass and plastics.	Explain how microwaves and infrared transfer energy to materials: • infrared is absorbed only by particles on the surface of the food increasing their KE • KE is transferred to the centre of the food by conduction or convection • microwaves are absorbed only by water or fat particles in outer layers of the food increasing their KE. Describe how the energy associated with microwaves and infrared depend on their frequency and relate this to their potential dangers.
Describe factors that limit the transmission of information over large distances using microwaves.	Explain how signal loss with microwaves happens because of: • adverse weather and large areas of surface water scatter signals • loss of line of sight due to curvature of the Earth • no diffraction of microwaves around large objects • interference between signals. Describe how the problems of signal loss are reduced by: • limiting the distance between transmitters • high positioning of transmitters.
Describe why there may or may not be dangers: • to residents near the site of a mobile phone transmitter mast • to users of mobile phones. Describe how potential dangers may be increased by frequent use. Explain how publishing scientific studies into the effects of mobile phone microwave radiation enables results to be checked.	Understand that in the presence of conflicting evidence individuals and society must make choices about mobile phone usage and location of masts in terms of balancing risk and benefit.

Module P1: Energy For The Home

Item P1f: Data transmission

Summary: Infrared radiation is not only useful for cooking and heating. It is used in remote controls to make life easier, whether it is changing channels on the television, opening car doors or opening the garage door when we get home on a cold, wet evening. Infrared radiation is also used to carry information in signals that can be transmitted over long distances using optical fibres. This item considers how we use infrared radiation.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine the properties of infrared radiation e.g. reflecting the beam from a remote control to a television and showing it to be absorbed.	Describe everyday uses of infrared radiation to include: • in remote controls (TV, video and DVD players, automatic doors) • short distance data links for computers or mobile phones.
Examine a passive infrared sensor and images captured by infrared cameras.	Understand how passive infrared sensors and thermal imaging cameras work: • infrared sensors detect body heat.
Examine waveforms of analogue and digital signals using an oscilloscope. Carry out research using the internet, to evaluate the reasons for, and time scale of, the switching from analogue to digital broadcasts. Construct a time line (on paper or using IT) to show the progression from the first radio and TV broadcasts to the use of digital transmissions.	Describe the differences between analogue and digital signals: • analogue signals have a continuously variable value • digital signals are either on (1) or off (0).

Module P1: Energy For The Home

Item P1f: Data transmission

Links to other items: P1c: A spectrum of waves, P1d: Light and lasers

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how infrared signals can carry information to control electrical or electronic devices.	Explain how the signal from an infrared remote control uses a set of digital signals (or codes) to control different functions of electrical or electronic devices.
Understand why it is easier to remove noise from most digital signals.	Explain how the properties of digital signals played a part in the switch to digital TV and radio broadcasts, to include use of multiplexing.
Describe the transmission of light in optical fibres: • optical fibres allow the rapid transmission of data • optical fibres allow the transmission of data pulses using light.	Describe advantages of using optical fibres to allow more information to be transmitted: • multiplexing • lack of interference in the final signal.

Module P1: Energy For The Home

Item P1g: Wireless signals

Summary: Today's hi-tech world demands that people can always receive both phone calls and email very rapidly. This item develops ideas about global communication, the benefits of wireless transmission, and the impact of this culture on modern society. The expanding use of digital signals is examined.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey of use of wireless technology within the class. Make a wall chart or PowerPoint presentation to illustrate the many uses of wireless technology.	Describe how radiation used for communication can be reflected. Recognise that wireless technology uses electromagnetic radiation for communication. Describe the advantages of wireless technology: • no external/direct connection to a telephone line needed • portable and convenient • allows access when on the move but an aerial is needed to pick up the signals.
Use radio or programme guides to make a chart of radio stations and frequencies. Examine the quality of radio and mobile phone reception in the area. Show that the quality of digital radio reception is superior to analogue reception. Research the expansion of Digital Audio Band (DAB) broadcasting. Construct a timeline to show the events from the first transmission of radio signals to the digital switch over.	Interpret data, including information given in diagram form, on digital and analogue signals.

Module P1: Energy For The Home

Item P1g: Wireless signals

Links to other items: P1c: A spectrum of waves

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall how radiation used for communication can be refracted and reflected and how this can be an advantage or disadvantage for good signal reception. Describe common uses of wireless technology: • TV and radio • mobile phones • laptop computers.	Explain how long-distance communication depends on: • the refraction and resulting reflection of waves from the ionosphere • being received by and re-transmitted from satellites. Recall that the refraction and reflection in the Ionosphere is similar to TIR for light.
Understand why nearby radio stations use different transmission frequencies. Describe advantages and disadvantages of DAB broadcasts: • more stations available • less interference with other broadcasts • may give poorer audio quality compared to FM • not all areas covered.	Explain how the refraction and diffraction of radiation can affect communications: • refraction at the interfaces of different layers of Earth's atmosphere • diffraction by transmission dishes results in signal loss. Explain the advantage of digital radio, in terms of lack of interference, including that between other broadcasts/stations.

Module P1: Energy For The Home

Item P1h: Stable Earth

Summary: Waves carry information. The information can be extracted even from naturally occurring waves, such as seismic waves generated within the Earth. Some waves are potentially harmful to living organisms. The incidents of skin cancer are rising, even in the UK. This item develops ideas surrounding these and other observations. It also examines how climate is being affected by natural and human activity.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine seismographic traces of recent earthquakes. Make a seismic trace using a pen suspended from a retort stand and striking the bench. Test seismometer applications in modern smart phones.	Describe earthquakes as producing shock waves which can: • be detected by seismometers • be recorded on a seismograph • cause damage to buildings and the Earth's surface • cause a tsunami.
Examine data that shows the increase in cases of skin cancer linked to more frequent exposure to UV. Produce a wall chart or PowerPoint presentation showing the dangers of exposure to UV and/or protection measures against over exposure. Make a leaflet to show people the dangers of using sun beds. Construct a chart showing a range of sun protection factors (SPFs) and the corresponding safe exposure times.	Recall that exposure to ultraviolet radiation can cause: • suntan • sunburn • skin cancer • cataracts • premature skin aging. Recognise that sunscreens (e.g. sun block or sun cream) can reduce damage caused by ultraviolet radiation: • less damage when higher factors are used • high factors allow longer exposure without burning.
Produce a wall chart showing how pollution from CFCs has enlarged the hole in the ozone layer over Antarctica and the resulting increased threat of exposure to more UV in that area.	Recall that the discovery of the reduction of ozone levels over Antarctica was unexpected. Describe how scientists used existing scientific ideas to explain their measurements.

Module P1: Energy For The Home

Item P1h: Stable Earth

Links to other items: C2a: The structure of the Earth

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that two types of seismic waves are: • longitudinal P waves which travel through both solids and liquids and travel faster than S waves • transverse S waves which travel through solids but not through liquids and travel slower than P waves.	Describe how data on seismic waves transmitted through the Earth can be used to provide evidence for its structure: • P waves travel through solid and liquid rock (i.e. all layers of the Earth) • S waves cannot travel through liquid rock (i.e. the outer core).
Explain how darker skins reduce cancer risk: • absorb more ultraviolet radiation • less ultraviolet radiation reaches underlying body tissues. Interpret data about sun protection factor (no recall is expected). Calculate how long a person can spend in the Sun without burning from knowledge of the sun protection factor (SPF) of sunscreens (e.g. sun block or sun cream). Describe how people have been informed of the risk of exposure to ultraviolet radiation, including from the use of sun beds, in order to improve public health.	Explain how the ozone layer protects the Earth from ultraviolet radiation. Describe how: • environmental pollution from CFCs has depleted the ozone layer • this allows more ultraviolet radiation to reach Earth • the potential danger to human health increases because of this.
Describe how scientists verified their measurements of ozone reduction, and the steps they took to increase confidence in their explanation: • measurements repeated with new equipment • measurements repeated by different scientists • predictions tested based on the explanation.	Describe how the discovery of the hole in the ozone layer over Antarctica changed the behaviour of society at an international level.

3.7 Module B2: Understanding Our Environment

Module B2: Understanding Our Environment

Item B2a: Classification

Summary: We are surrounded by a huge variety of living organisms. Through classifying them according to their similarities and differences, we can better understand the evolutionary and ecological relationships between living organisms. The ability to correctly classify organisms is crucial if we are to identify and maintain global biodiversity.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Place different organisms into groups.	Understand that organisms can be classified into groups according to shared characteristics. Describe the characteristics used to place organisms into the five Kingdoms.
Collect invertebrates from local surroundings and develop a simple key. Use a simple key to identify some invertebrates.	Use characteristics to place organisms into the different classes of arthropod, limited to: • insects • arachnids • crustaceans • myriapods.
Research the work of John Ray and Carl Linnaeus in developing a modern classification system.	Recognise that organisms of the same species: • may show great variation • have more features in common than they do with organisms of a different species.
	Understand why similar species tend to live in similar types of habitats.

Module B2: Understanding Our Environment

Item B2a: Classification

Links to other items: B1h: Variation and inheritance, B2f: Natural selection

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand that the variety of life is a continuous spectrum which makes it difficult to place organisms into distinct groups. Describe the classification of organisms into kingdom, phylum, class, order, family, genus and species. Explain the importance of classification of species in terms of identifying evolutionary and ecological relationships.	Describe classification systems to include natural (based on evolutionary relationships) and artificial (for purposes of identification). Explain how the use of DNA sequencing information has led to changes in understanding of classification. Understand why systems of classification change over time.
Understand that the evolutionary relationships between organisms can be displayed using evolutionary trees.	Understand how the evolutionary relationships of organisms in a group can be modelled by analysing multiple characteristics and how this has been facilitated by ICT.
Define the term 'species' as a group of organisms which are capable of interbreeding to produce fertile offspring. Explain the importance of the binomial system as the international basis for naming species.	Explain some of the problems of classifying organisms into species, to include: • hybrids • organisms that only reproduce asexually • evolution as a continuing process.
Recall that closely related species: • share a relatively recent ancestor • may have different features if they live in different types of habitats.	Explain how similarities and differences between species can be explained in terms of both evolutionary and ecological relationships.

Module B2: Understanding Our Environment

Item B2b: Energy flow

Summary: All living things need energy to live. Ultimately this energy comes from the Sun. This item explains how energy from the Sun flows through ecosystems and how humans can harness it. The work on energy transfer provides the opportunity to examine the ethical issues raised by decisions on plant use and the environmental effects of such decisions.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Research food chains in different habitats.	Explain the term trophic level. Understand that there are organisms other than green plants that are producers. Explain why some organisms are both primary and secondary consumers. Explain how changes in the population of one organism may affect the other organisms in a food web.
Survey peers on vegetarian diet. Consider and compare sources of food.	Explain how energy from the Sun flows through food webs. Interpret data on energy flow in food webs.

Module B2: Understanding Our Environment

Item B2b: Energy flow

Links to other items: B2c: Recycling, B2d: Interdependence

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand how pyramids of biomass show the dry mass of living material at each stage of a food chain. Construct pyramids of biomass from given information. Explain why pyramids of numbers and pyramids of biomass for the same food chains can be different shapes.	Explain the difficulties in constructing pyramids limited to: • organisms may belong to more than one trophic level • the problems with measuring dry biomass.
Explain how some energy is transferred to less useful forms at each stage (trophic level) in the food chain, to include: • heat from respiration • excretion • egestion. Describe how excretory products, faeces and uneaten parts can be used as the starting point for other food chains.	Explain how the efficiency of energy transfer explains the shape of pyramids of biomass. Explain how the efficiency of energy transfer explains the limited length of food chains. Calculate the efficiency of energy transfer.

Module B2: Understanding Our Environment

Item B2c: Recycling

Summary: We are encouraged to recycle to save the Earth's resources, but natural recycling is nothing new. The survey of local recycling schemes provides the opportunity to use ICT sources and tools to collect secondary data.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey of local recycling schemes. Compare local recycling schemes with national and international recycling schemes. Composting activities. Observation/measurement of leaf decomposition in hedges.	Recall that when animals and plants die and decay the elements in their bodies are recycled. Recognise that many soil bacteria and fungi are decomposers, which decay dead organisms. Describe the importance of this decay process in making elements available again to living organisms. Recognise that as animals and plants grow they take in chemicals and incorporate elements from these into their bodies. Recall that two of the most important elements that are required are: • carbon • nitrogen. Recall that carbon is taken up by plants as carbon dioxide.
Carry out an experiment to test soil for nitrates. Examine clover roots to see nodules. Make a nitrogen cycle snakes and ladders game. Investigate nitrogen fixing bacteria (see Practical Microbiology for Secondary Schools).	Recall that nitrogen is taken up by plants as nitrates. Recall the abundance of nitrogen in the air (78%). Explain why nitrogen gas can't be used directly by animals or plants, in terms of its reactivity.

Module B2: Understanding Our Environment

Item B2c: Recycling

Links to other items: B2b: Energy flow

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain why recycling of nutrients takes longer in waterlogged or acidic soils than it does in well drained neutral soils. Explain how carbon is recycled in nature, limited to: • plants removing carbon dioxide from the air by photosynthesis • feeding passes carbon compounds along a food chain or web • plants and animals releasing carbon dioxide into the air, as a product of respiration • burning of fossil fuels (combustion) releasing carbon dioxide • soil bacteria and fungi, acting as decomposers, releasing carbon dioxide into the air.	Explain how carbon is recycled in nature, limited to: • marine organisms making shells made of carbonates • shells becoming limestone • carbon returning to the air as carbon dioxide during volcanic eruption or weathering • oceans absorbing carbon dioxide, acting as carbon sinks.
Explain how nitrogen is recycled in nature, limited to: • plants taking in nitrates from the soil to make protein for growth • feeding passes nitrogen compounds along a food chain or web • nitrogen compounds in dead plants and animals being broken down by decomposers and returning to the soil.	Explain how nitrogen is recycled in nature, limited to: • soil bacteria and fungi, acting as decomposers, converting proteins and urea into ammonia • the conversion of this ammonia to nitrates by nitrifying bacteria • the conversion of nitrates to nitrogen gas by denitrifying bacteria • the fixing of nitrogen gas by nitrogen-fixing bacteria living in root nodules or in the soil, or by the action of lightning.

Module B2: Understanding Our Environment

Item B2d: Interdependence

Summary: This item seeks to help candidates understand that there is a struggle for existence and the survival of animals and plants depends on how they cope with competition and predation. There are also other types of interdependence to include parasitism and organisms co-existing to their mutual benefit.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey a habitat and produce a display to show the plants/animals competing in the habitat. For example, why are 'weeds' successful competitors? Research invasive species, for example Himalayan balsam, Japanese knotweed and American crayfish.	Explain how competition may influence the distribution and population size of animals or plants, related to the availability of food, water, shelter, light and minerals. Interpret data which shows that animals and plants can be affected by competition for resources, including population sizes and distribution data.
	Explain how the size of a predator population will affect the numbers of prey and vice versa.
Examine root nodules using a hand lens. Research examples of mutualism and other associations between organisms. Research how parasites are adapted to survive in/on their particular hosts.	Recall that some organisms benefit from the presence of organisms of a different species. Describe one example of such a relationship, limited to cleaner species, to include oxpecker and buffalo.

Module B2: Understanding Our Environment

Item B2d: Interdependence

Links to other items: B2b: Energy flow, B2c: Recycling, B2e: Adaptations, B2f: Natural selection

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how similar animals in the same habitat will be in close competition. Describe how organisms within a species compete in order to survive and breed.	Use the terms interspecific and intraspecific to describe given examples of competition and explain why intraspecific competition is often more significant. Explain what is meant by the term ecological niche. Understand that similar organisms will occupy similar ecological niches.
Explain how the populations of some predators and their prey show cyclical fluctuations in numbers.	Explain why the cycles of population for predator and prey are out of phase with each other.
Describe other types of interdependence between organisms to include: • parasitism, where the parasite benefits to the living host's detriment, including fleas and tapeworms • mutualism, where both species benefit including cleaner species and pollination by insects.	Explain how the interdependence of organisms determines their distribution and abundance. Explain why nitrogen-fixing bacteria in the root nodules of leguminous plants are an example of mutualism.

Module B2: Understanding Our Environment

Item B2e: Adaptations

Summary: Our environment is constantly changing. This affects animal and plant distributions. This item develops ideas about how some plants and animals successfully adapt to suit their changing environment.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Using a hand lens, observe a worm and list all of its adaptations that make it successful for life in the soil. Make a model of a plant and discuss the adaptations that make it successful. Research organisms that have lost/reduced features that are no longer required e.g. blind cave fish that have lost eyes. Carry out an internet search to find pictures of animals or plants with successful camouflage and other adaptations. Identify predators and discuss the adaptations that will make them successful. Use ICT to make a poster to explain how an organism is adapted to its habitat.	Explain how some animals are adapted to be successful predators, to include: • binocular vision to judge distance and size • hunting strategy • breeding strategy. Explain how some animals are adapted to avoid being caught as prey, to include: • eyes on side of head for wide field of view • living in groups (herds or shoals) to reduce the chance of being caught • cryptic and warning colouration • mimicry • breeding strategy (synchronous breeding).
Discuss possible climate changes and predict which animals and plants will successfully adapt to survive in the new conditions.	Recall that animals and plants that are adapted to their habitats are better able to compete for limited resources.

Module B2: Understanding Our Environment

Item B2e: Adaptations

Links to other items: B2d: Interdependence, B2f: Natural selection

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how adaptations to cold environments help organisms survive, to include: • anatomical methods of reducing heat loss including insulation and surface area • behavioural adaptations, including migration and hibernation. Explain how adaptations to hot environments help organisms survive, to include: • behavioural and anatomical methods of increasing heat loss • behavioural methods of reducing heat gain. Explain how adaptations to dry environments help organisms survive, to include: • behavioural, anatomical and physiological methods for coping with lack of water.	Analyse surface area to volume ratios in the context of different environmental stresses. Explain how counter-current heat exchange systems (e.g. in penguins) minimise heat loss. Understand that some organisms are biochemically adapted to extreme conditions, including different optimum temperature for enzymes in extremophiles and organisms with antifreeze proteins.
Explain how animals and plants that are adapted to an environment are better able to compete for limited resources.	Describe how some organisms are: • specialists, which are well suited to only certain habitats • generalists, which can live in a range of habitats but can easily be out-competed.

Module B2: Understanding Our Environment

Item B2f: Natural selection

Summary: The concept of evolution is well known. However, the mechanism of evolution by natural selection is commonly misunderstood. This item discusses evidence for evolution as well as its mechanism. It also looks at how scientific theories develop and why some become accepted and some do not.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Draw a poster to show how natural selection takes place. Design a newspaper article telling people about Charles Darwin's observations and theories. Research the role of Alfred Russell Wallace in developing the theory of natural selection. Research Charles Darwin and his voyages. Plot the distribution of the peppered moth on a map showing major cities. Research resistant bacteria and discuss the problems they cause in hospitals. Research species that do not appear to have evolved but have stayed as they are for millions of years, so called 'living fossils', e.g. coelacanth, crocodiles, sharks and Ginkgo and suggest why they do not appear to have changed.	Identify variations within a population of organisms of the same species. Explain why animals and plants that are better adapted to their environment are more likely to survive. Recognise that over long periods of time, groups of organisms can change and that this is called evolution. Understand how when environments change, some animal and plant species survive or evolve but many become extinct.
Research Lamarck and his ideas about evolution.	Recall that: • many theories have been put forward to explain how evolution may occur • most scientists accept the theory of natural selection first put forward by Charles Darwin.

Module B2: Understanding Our Environment

Item B2f: Natural selection

Links to other items: B1h: Variation and inheritance, B2a: Classification, B2d: Interdependence, B2e: Adaptations

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand Darwin's theory of evolution by natural selection, to include: • presence of natural variation • competition for limited resources • survival of the fittest • inheritance of 'successful' adaptations. Recall that adaptations are controlled by genes and that these genes can be passed on to the next generation.	Explain how over long periods of time the changes brought about by natural selection may result in the formation of new species. Understand why speciation requires geographical or reproductive isolation of populations.
Explain the reasons why the theory of evolution by natural selection met with an initially hostile response (social and historical context). Recognise that natural selection as a theory is now widely accepted: • because it explains a wide range of observations • because it has been discussed and tested by a wide range of scientists.	Explain how Lamarck's idea of evolution by the inheritance of acquired characteristics was different from Darwin's theory. Explain why Lamarck's theory was discredited: his explanation did not have a genetic basis. Recognise that the theory of natural selection has developed as new discoveries have been made, to include the understanding of inheritance.

Module B2: Understanding Our Environment

Item B2g: Population and pollution

Summary: Young people are aware of the increasing human population and how this is related to an increase in pollution levels. The use of living and non-living indicators of pollution are considered.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Plot the increase in population and compare with the increase in a pollutant. Draw a poster to show the percentage of different types of household waste found in the average family dustbin.	Recognise that the human population is increasing. Recognise that the human population uses resources, some of which are finite, to include: • fossil fuels • minerals.
Investigate the germination of seeds and the growth of seedlings in different levels of acid rain.	Explain how as the human population increases, resource use increases and therefore more pollution is created; pollutants, limited to: • household waste • sewage • sulfur dioxide from burning fossil fuels • carbon dioxide from burning fossil fuels.
Research the methods used to measure the increase in levels of carbon dioxide in the past 200 years. Research possible links between the data concerning carbon dioxide levels and global temperatures. Explore impacts of chemicals on plant growth www-saps.plantsci.cam.ac.uk/.	Understand that pollution can affect the number and type of organisms that can survive in a particular place.

Module B2: Understanding Our Environment

Item B2g: Population and pollution

Links to other items: B2h: Sustainability

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand that the human population is increasing exponentially. Understand that population growth is the result of the birth rate exceeding the death rate. Explain the causes and consequences of: • global warming • ozone depletion • acid rain.	Explain how the developed countries of the world, with a small proportion of the world's population, have the greatest impact on the use of resources and the creation of pollution. Explain the term 'carbon footprint' in terms of the amount of greenhouse gases given off in a certain period of time. Discuss the possible consequences of exponential growth.
Explain how the presence/absence of indicator species helps to indicate the level of pollution, to include: • water pollution – waterlouse sludgeworm, rat-tailed maggot and mayfly larva • air pollution – lichen. Describe how pollution can be measured: • by direct measurement of pollutant levels • by measuring the occurrence of indicator species.	Interpret data on indicator species. Describe the advantages and disadvantages of using living and non-living methods of measuring levels of pollution.

Module B2: Understanding Our Environment

Item B2h: Sustainability

Summary: Sustainable development is a term that is becoming more widely used and refers to the economic exploitation of the environment in a way that can be maintained without causing permanent damage. We are also conscious of the damage that has already been done and are trying to protect endangered habitats and species. This item develops ideas about our choices and responsibilities with particular reference to whales.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Make a display of endangered and extinct plants and animals. Research organisms that used to exist in the UK. Use ICT to produce an information leaflet on one endangered species, showing reasons for its predicament and suggestions for its protection, using the IUCN red list. Research the use of seed banks (extinct plants project at Kew).	Explain why organisms become extinct or endangered, to include: • climate change • habitat destruction • hunting • pollution • competition. Describe how endangered species can be conserved, to include: • protecting habitats • legal protection • education programmes • captive breeding programmes • seed banks • creating artificial ecosystems.
Search the internet for information on an endangered species. Class discussion on nature reserves 'Why should we have zoos/marine parks/nature reserves?' Plot the distributions of whale species on a world map.	Interpret data which shows that whale species' distributions depend on their feeding habitats. Discuss the reasons why certain whale species are close to extinction.
	Recognise that a sustainable resource can be removed from the environment without it running out. Recall that some resources can be maintained, limited to: • fish stocks • woodland.

Module B2: Understanding Our Environment

Item B2h: Sustainability

Links to other items: B2f: Natural selection, B2g: Population and pollution

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain reasons for conservation programmes, to include: • protecting human food supply • ensuring minimal damage to food chains • future identification of plants for medical purposes • cultural aspects. Explain why species are at risk of extinction if the number of individuals or habitats falls below a critical level.	Explain why species are at risk of extinction if there is not enough genetic variation in the population. Evaluate a given example of a conservation programme in terms of: • genetic variation of key species • viability of populations • available habitats • interaction between species.
Recognise that both living and dead whales have commercial value: tourism when alive; food, oil and cosmetics when dead. Describe issues arising from keeping whales in captivity: entertainment, research, captive breeding programmes and lack of freedom.	Recognise that some aspects of whale biology are still not fully understood: communication, migration patterns and survival at extreme depths. Describe issues concerning whaling, to include: getting international agreement, policing and enforcing such agreements and hunting for research.
Explain the term sustainable development as providing for the needs of an increasing population without harming the environment. Explain how fish stocks and woodland can be sustained and developed using: • education • quotas on fishing • re-planting of woodland.	Explain the importance of population size, waste products and food and energy demands in the achievement of sustainable development. Understand that sustainability requires planning and co-operation at local, national and international levels. Describe how sustainable development may protect endangered species.

3.8 Module C2: Chemical Resources

Module C2: Chemical Resources

Item C2: 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 practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
These learning outcomes are intended to be taught throughout this specification.	Understand that in a chemical reaction reactants are changed into products. Recognise the reactants and products in a word equation. Construct word equations given the reactants and products.
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.	Deduce the number of elements in a compound given its formula. Deduce the number of atoms in a formula with no brackets. Deduce 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. Deduce the names of the different elements in a compound given its formula.
These learning outcomes are intended to be taught throughout this specification.	Understand that a molecule is made up of more than one atom joined together. Understand that a molecular formula shows the numbers and types of atom in a molecule. Deduce the number of atoms in a displayed formula. Deduce the names of the different elements in a compound given its displayed formula. Deduce the number of each different type of atom in a displayed formula.
These learning outcomes are intended to be taught throughout this specification.	Recognise whether a particle is an atom, molecule or ion given its formula. Understand that atoms contain smaller particles one of which is a negative electron.
These learning outcomes are intended to be taught throughout this specification.	Recall that two types of chemical bond holding atoms together are: • ionic bonds • covalent bonds.

Module C2: Chemical Resources

Item C2: Fundamental Chemical Concepts

Links to other items: C1 to C6

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Construct word equations (not all reactants and products given).	
Construct balanced symbol equations given the formulae (no brackets) of the reactants and products. Explain why a symbol equation is balanced.	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 C2).
Deduce the number of atoms in a formula with brackets. Deduce the number of each type of different atom in a formula with brackets. Recall the formula of the following substances: • calcium carbonate and calcium oxide • carbon dioxide, hydrogen and water • sodium chloride and potassium chloride • ammonia and nitrogen • hydrochloric acid.	Recall the formula of the following substances: • nitric acid and sulfuric acid • copper oxide, sodium hydroxide, potassium hydroxide and sodium carbonate • potassium sulfate, sodium sulfate and ammonium sulfate • calcium chloride, magnesium chloride magnesium sulfate and copper(II) sulfate.
Understand 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.	Construct balanced equations using displayed formulae.
Understand that positive ions are formed when electrons are lost from atoms. Understand that negative ions are formed when electrons are gained by atoms.	
Understand that an ionic bond is the attraction between a positive ion and a negative ion. Understand that a covalent bond is a shared pair of electrons.	Explain how an ionic bond is formed. Explain how a covalent bond is formed.

Module C2: Chemical Resources

Item C2a: The structure of the Earth

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. The development of the theory of plate tectonics illustrates science as an evidence based discipline, the collaborative nature of science and how scientific theories develop and are validated. It also covers how the Earth's surface has changed over time.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Create a scale 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. 'Wegener and continental drift' example taken from the Collins Ideas and Evidence CD.	Describe the structure of the Earth as a sphere with a thin rocky crust, a mantle and an iron core. Understand how the movement of tectonic plates results in volcanic activity and earthquakes. Recall that the movement of tectonic plates is very slow (about 2.5cm per year). Understand the timescales involved in the movement of continents. Recognise that: • many theories have been put forward to explain the nature of the Earth's surface • Earth scientists accept the theory of plate tectonics.
Model a volcano using the candle wax experiment. Look for clues contained in volcanic rocks that show how they formed. Video clips of volcano types. Treacle investigation.	Explain how the size of crystals in an igneous rock is related to the rate of cooling of molten rock. Describe magma as molten rock beneath the surface of the Earth and lava as molten rock at the Earth's surface. Recall that some volcanoes erupt runny lava, while some erupt thick lava violently and catastrophically.
Research examples of people who live near volcanoes and the reasons why.	Explain why some people choose to live near volcanoes.

Module C2: Chemical Resources

Item C2a: The structure of the Earth

Links to other items: C2b: Construction materials

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the lithosphere as the (relatively) cold rigid outer part of the Earth that includes the crust and part of the mantle. Describe the lithosphere as made of tectonic plates that are less dense than the mantle below. Explain the problems associated with studying the structure of the Earth: • crust is too thick to drill through • the need to use seismic waves produced by earthquakes or man-made explosions. Explain why the theory of plate tectonics is now widely accepted: • it explains a wide range of evidence • it has been discussed and tested by a wide range of scientists.	Describe the mantle as the zone between the crust and the core which is: • cold and rigid just below the crust • hot and non-rigid at greater depths and therefore able to move. Describe the theory of plate tectonics: • energy transfer involving convection currents in the semi-rigid mantle causing the plates to move slowly • oceanic crust more dense than continental crust • collision between oceanic plate and continental plate leads to subduction and partial melting • plates cooler at ocean margins so sink and pull plates down. Describe in simple terms the development of the theory of plate tectonics: • Wegener's continental drift theory (1914) • continental drift theory not accepted by scientists at the time • new evidence in 1960s – sea floor spreading • theory of plate tectonics slowly accepted by the scientific community as subsequent research has supported the theory.
Understand that the type of volcanic eruption depends on the composition of the magma.	Describe different types of igneous rocks that are formed from lava: • iron-rich basalt is formed from runny lava from a fairly safe volcanic eruption • silica-rich rhyolite is formed from thick lava from an explosive eruption.
Explain why geologists study volcanoes: • to be able to forecast future eruptions • to reveal information about the structure of the Earth.	Explain why geologists are now able to better forecast volcanic eruptions but not with 100% certainty.

Module C2: Chemical Resources

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 the Earth or on the Earth's surface. The removal of the raw materials and their use has an enormous impact on the environment.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Data-search about construction materials and their sources.	Recall that some rocks are used in construction of buildings and roads: • granite, limestone, marble and aggregates.
Look at samples of marble, limestone and granite. Video clips of mining and quarrying.	Explain why there are environmental problems when rocks are quarried or mined from the ground: • landscape destroyed and has to be reconstructed when the mining or quarrying has finished • increased noise, traffic and dust.
Experimental investigation of the decomposition of calcium carbonate.	Recall that limestone and marble are both forms of calcium carbonate. Recall that limestone thermally decomposes to make calcium oxide and carbon dioxide.
Making a sample of concrete.	Describe how concrete is made: • cement, sand, aggregate and water are mixed together • mixture then allowed to set.
Investigating the strength of concrete beams.	Describe how concrete can be reinforced using a steel support.

Module C2: Chemical Resources

Item C2b: Construction materials

Links to other items: C2a: The structure of the Earth, C2d: Making cars

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Relate some construction materials to the substances found in the Earth's crust from which they are manufactured: • aluminium and iron from ores • brick from clay • glass from sand.	
Compare the hardness of limestone, marble and granite.	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.
Construct the word equation for the decomposition of limestone (products not given) calcium carbonate → calcium oxide + carbon dioxide Construct the balanced symbol equation for the decomposition of limestone (given some formulae): $CaCO_3 \rightarrow CaO + CO_2$ Describe thermal decomposition as a reaction in which, when heated, one substance is chemically changed into at least two new substances.	Construct the balanced symbol equation for the decomposition of limestone (formulae not given): $CaCO_3 \rightarrow CaO + CO_2$
Recall that cement is made when limestone and clay are heated together.	
Recall that reinforced concrete is a composite material.	Explain why reinforced concrete is a better construction material than non-reinforced concrete in terms of: • hardness of the concrete • flexibility and strength of the steel.

Module C2: Chemical Resources

Item C2c: 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 practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Extraction of copper by heating malachite and carbon. Experimental purification of copper by electrolysis.	Understand how copper can be extracted by heating its ore with carbon. Describe reduction as the removal of oxygen from a substance. Recall that copper can be purified by electrolysis. Explain why recycling copper is cheaper than extracting copper from its ore: • saves resources • uses less energy.
Research about alloys – their uses and composition. Data search or experimental investigation into the properties of alloys. Modelling alloys with plasticine see RSC website www.practicalchemistry.org. Making solder and comparing its properties with lead and tin see RSC website www.practicalchemistry.org.	Recall that alloys are mixtures containing one or more metal elements. Recognise that brass, bronze, solder, steel, and amalgam are alloys. Recall one important large scale use for each of the following alloys: • amalgam used in tooth fillings • brass used in musical instruments, coins and door decorations e.g. door knockers • solder used to join electrical wires.
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. Suggest properties needed by a metal or alloy for a particular given use.

Module C2: Chemical Resources

Item C2c: Metals and alloys

Links to other items: C2d: Making cars

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Label the apparatus needed to purify copper by electrolysis. Explain some of the advantages and disadvantages of recycling copper.	Describe the use of electrolysis in the purification of copper: • impure copper as anode • pure copper as cathode • copper(II) sulfate solution as electrolyte • cathode gains mass because copper is deposited • anode loses mass as copper dissolves. Explain why the electrolytic purification of copper involves both oxidation and reduction: • $Cu^{2+} + 2e^- \rightarrow Cu$ as an example of reduction because electrons are gained • $Cu - 2e^- \rightarrow Cu^{2+}$ as an example of oxidation because electrons are lost.
Recall the main metals in each of the following alloys: • amalgam – mercury • brass – copper and zinc • solder – lead and tin.	
Explain why metals, including alloys are suited to a given use given appropriate data (no recall expected).	Evaluate the suitability of metals for a given use given appropriate data. Explain how the use of 'smart alloys' such as those with a shape memory property have increased the number of applications of alloys: • nitinol (nickel and titanium) used to make spectacle frames as the frames will return to their original shape after bending.

Module C2: Chemical Resources

Item C2d: Making cars

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 practical and research activities 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.	Recall that rusting needs iron, water and oxygen. Recall that aluminium does not corrode in moist conditions. Describe oxidation as the addition of oxygen or the reaction of a substance with oxygen. Interpret simple 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 both by data search and 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.	Compare the properties of iron and aluminium: • iron is more dense than aluminium • iron is magnetic and aluminium is not • iron corrodes (rusts) easily and aluminium does not • iron and aluminium are both malleable • iron and aluminium are both good electrical conductors.
Research all the materials that are used to manufacture cars (e.g. plastics, fibres, glass, copper, iron, aluminium).	Recall 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.

Module C2: Chemical Resources

Item C2d: Making cars

Links to other items: C2b: Construction materials, C2c: Metals and alloys

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand how salt water and acid rain affect rusting. Understand that rusting is an oxidation reaction (iron reacts with oxygen forming an oxide). Construct the word equation for rusting: iron + oxygen + water → hydrated iron(III) oxide. Explain why aluminium does not corrode in moist conditions. Interpret data about the rate of corrosion of different metals in different conditions (no recall is expected).	
Understand 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 to include: • 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: • get better fuel economy because the car body of the same car will be lighter with aluminium • longer lifetime because the car body with aluminium will corrode less.
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 particular use given appropriate data (no recall expected).	
Explain the advantages and disadvantages of recycling the materials used to make cars. Explain why new laws 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: Chemical Resources

Item C2e: Manufacturing chemicals: making ammonia

Summary: This item is introduced using the context of the industrial preparation of ammonia using chemicals from the air 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 has to be struck between rate and percentage conversion is explored more generally. 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 provide opportunities to present information using technical, scientific and mathematical language.

Suggested practical and research activities 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 e.g. Multimedia Science School 11-16 or Boardworks. Industrial case study. Watch video of Haber process with pre-prepared questions.	Recall that in the Haber process ammonia is made from nitrogen from the air and hydrogen that comes from the cracking of oil fractions or from natural gas.
Research 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 materials • 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. Understand that a reversible reaction proceeds in both directions.
Survey of household chemicals containing ammonia and their uses.	Recall some of the uses of ammonia: • manufacture of fertilisers • manufacture of nitric acid.

Module C2: Chemical Resources

Item C2e: Manufacturing chemicals: making ammonia

Links to other items: C2g: Fertilisers and crop yields

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. Construct the balanced symbol equation for the manufacture of ammonia in the Haber process (given some or all of the formulae): $N_2 + 3H_2 \rightleftharpoons 2NH_3$	Explain 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. Construct the balanced symbol equation for the manufacture of ammonia in the Haber process (formulae not given): $N_2 + 3H_2 \rightleftharpoons 2NH_3$
Describe how different factors affect the cost of making a new substance: • the higher the pressure the higher the plant cost • the higher the 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 how 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 starting 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 C2: Chemical Resources

Item C2f: 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 practical and research activities 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 data logger). Test everyday household substances.	Describe how universal indicator can be used to estimate the pH of a solution. Recall the colour changes with litmus.
Simple investigation into the change in pH during neutralisation (not pH titration curves).	Recall that an alkali is a soluble base.
Investigate the reactions of acids with bases and carbonates e.g. hydrochloric acid with metal oxides, hydroxides and carbonates.	Understand that an acid can be neutralised by a base or alkali, or vice versa.

Module C2: Chemical Resources

Item C2f: Acids and bases

Links to other items: C2g: Fertilisers and crop yields

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Understand that indicators use colour change to show changes in pH, including: • sudden or gradual changes • colour changes over different pH ranges.	
Recall that in neutralisation: acid + base → salt + water. Recall that in solution all acids contain H^+ ions. Understand that the pH of an acid is determined by the concentration of H^+ ions.	Explain why an acid is neutralised by an alkali in terms of the ions present: • acids contain H^+ • alkalis contain OH^- • neutralisation involves the reaction $H^+ + OH^- \rightleftharpoons H_2O$
Explain why metal oxides and metal hydroxides neutralise acids. Recall that carbonates neutralise acids to give water, a salt and carbon dioxide. Construct word equations to show the neutralisation of acids by bases and carbonates (names of the products not given). Predict the name of the salt produced when a named base or carbonate is neutralised by a laboratory acid limited to: • sulfuric acid • nitric acid • hydrochloric acid • phosphoric acid.	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 C2: Chemical Resources

Item C2g: Fertilisers and crop yields

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 practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey of fertilisers available at garden centres and commercially (via internet searches). Research the main processes involved in eutrophication. Eutrophication animation or case study.	Recall that fertilisers increase crop yield. Recall that plants absorb minerals through their roots. 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. Understand that the use of fertilisers can be beneficial (increasing food supply) and also cause problems e.g. death of aquatic organisms (eutrophication).
Preparation of a fertiliser by the neutralisation of an acid by an alkali using a burette (e.g. potassium nitrate or ammonium sulfate).	Identify the apparatus needed to prepare a fertiliser by the neutralisation of an acid with an alkali: • burette and measuring cylinder • filter funnel. Recall the names of two nitrogenous fertilisers manufactured from ammonia e.g.: • ammonium nitrate • ammonium phosphate • ammonium sulfate • urea.

Module C2: Chemical Resources

Item C2g: Fertilisers and crop yields

Links to other items: C2e: Manufacturing chemicals: making ammonia, C2f: Acids and bases

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain why fertilisers must be dissolved in water before they can be absorbed by plants. Identify arguments for and against the use of fertilisers: • world population is rising so need to produce more food • eutrophication and pollution of water supplies can result from excessive use of fertilisers.	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. Explain 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.
Predict the name of the acid and the alkali needed to make a named fertiliser, for example: • ammonium 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 C2: Chemical Resources

Item C2h: Chemicals from the sea: the chemistry of sodium chloride

Summary: The sea is a major source of salt. 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.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Research salt mining.	Recall that sodium chloride (salt) can be obtained from the sea or from salt deposits.
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.	Recall that the electrolysis of concentrated sodium chloride gives chlorine and hydrogen. Recall that the chemical test for chlorine is that it bleaches moist litmus paper.
Survey the range of products formed from salt.	Recall that sodium chloride is used: • as a preservative • as a flavouring. Understand that sodium chloride is an important raw material in the chemical industry, including use as a source of chlorine and sodium hydroxide. Recall that household bleach, pvc and solvents are made from substances derived from salt. Recall that chlorine is used to sterilise water and to make solvents, household bleach and plastics. Recall that hydrogen is used in the manufacture of margarine. Recall that sodium hydroxide is used to make soap.

Module C2: Chemical Resources

Item C2h: Chemicals from the sea: the chemistry of sodium chloride

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how salt can also be mined as rock salt and by solution mining in Cheshire. Explain how mining for salt can lead to subsidence.	
Recall the products of the electrolysis of concentrated sodium chloride solution (brine): • hydrogen made at the cathode • chlorine made at the anode • sodium hydroxide is also made. Explain why it is important to use inert electrodes in the electrolysis of sodium chloride solution.	Explain how the electrolysis of sodium chloride solution (brine) produces sodium hydroxide, hydrogen and chlorine: • $NaCl(aq)$ contains Na^+, OH^-, Cl^-, H^+ • cathode $2H^+ + 2e^- \rightarrow H_2$ • anode $2Cl^- - 2e^- \rightarrow Cl_2$ • ions not discharged make sodium hydroxide. Explain why the electrolysis of sodium chloride involves both reduction and oxidation.
Describe how sodium hydroxide and chlorine are used to make household bleach.	Explain the economic importance of the chlor-alkali industry.

3.9 Module P2: Living For The Future (Energy Resources)

Module P2: Living For The Future (Energy Resources)

Item P2a: Collecting energy from the Sun

Summary: The Sun has supplied our planet with energy for a long time. This item shows how solar energy can be used, in a sustainable way, to provide us with some of our energy needs.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate how the voltage and current from a photocell varies with distance from the light source. Research the use of photocells for providing electricity in remote locations. Investigate how the power of a photocell depends on its surface area and its distance from the light source. Investigate how photocells can be connected to increase their voltage.	Recall that photocells: • transfer light into electricity • produce direct current (DC) • can operate in remote locations • have a power or current that depends on the surface area exposed to sunlight. Recall that DC electricity is current in the same direction all the time.
Build a solar collector e.g. from aluminium foil and an umbrella. Investigate a model glasshouse. Survey and research the use of passive solar heating of buildings. Survey and research the use and distribution of wind turbines in the UK. Research and debate to what extent solar energy can help ensure the UK's future energy security.	Describe how the Sun's energy can be harnessed: • radiation from the Sun can be absorbed by a surface and transferred into heat energy • produces convection currents (wind) to drive turbines • how glass can be used to provide passive solar heating for buildings • light can be reflected to a focus by a curved mirror.

Module P2: Living For The Future (Energy Resources)

Item P2a: Collecting energy from the Sun

Links to other items: P2c: Global warming

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe some advantages and disadvantages of using photocells to provide electricity: • low maintenance • no need for power cables • no need for fuel • long life • renewable energy resource • no polluting waste • no power at night or in bad weather.	Describe how light produces electricity in a photocell: • energy absorbed by photocell • electrons are knocked loose from the silicon atoms in the crystal • electrons flow freely. Understand how the current and power produced in a photocell depends on: • light intensity • surface area exposed • distance from the light source.
Describe the advantages and disadvantages of wind turbines: • renewable • no polluting waste • visual pollution • dependency on wind speed • appropriate space and position needed.	Explain why passive solar heating works: • glass is transparent to Sun's radiation • heated surfaces emit infrared radiation of longer wavelength • glass reflects this longer wavelength infrared. Recall that an efficient solar collector must track the position of the Sun in the sky.

Module P2: Living For The Future (Energy Resources)

Item P2b: Generating electricity

Summary: Most of our electricity is generated in power stations by burning fuels. This item shows how power stations work and how energy is transported to our homes and factories.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Build a model generator with magnets and coils to produce electricity. Examine the difference between a model generator and the generator in a power station. Examine ways in which the current of a generator can be increased. Examine the output of a generator with an oscilloscope.	Describe how to generate electricity using the dynamo effect, by moving the coil or the magnet. Recall that a generator produces alternating current (AC). Recall that a battery produces direct current (DC).
Find out about the construction of power stations. Demonstrate a steam engine transferring the chemical energy of a fuel into kinetic energy.	Describe the main stages in the production and distribution of electricity: • source of energy • power station produces electricity • national grid of power lines connecting station to consumers • consumers are homes, factories, offices and farms.
	Recognise that there is significant waste of energy in a conventional power station. Use the equation in the context of a power station: $\text{efficiency} = \frac{\text{useful energy output } (\times 100\%)}{\text{total energy input}}$ given the useful energy output and the total energy input. Efficiency can be expressed in ratio or percentage terms.

Module P2: Living For The Future (Energy Resources)

Item P2b: Generating electricity

Links to other items: P2c: Global warming, P2d: Fuels for power

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe and recognise the ways that the dynamo effect can be increased (to give more current). Describe and interpret AC using a voltage-time graph.	
Describe how simple AC generators work: • coil of wire • magnetic field • coil and field close • relative motion between coil and field. Describe how electricity is generated at a conventional power station: • burning fuel • producing steam • spinning a turbine • turbine turns generator.	
Use the equation in the context of a power station: $\text{efficiency} = \frac{\text{useful energy output } (\times 100\%)}{\text{total energy input}}$ given the useful energy output, wasted energy and the total energy input. Efficiency can be expressed in ratio or percentage terms.	Use the equation in the context of a power station to calculate useful energy output, total energy input or wasted energy. $\text{efficiency} = \frac{\text{useful energy output } (\times 100\%)}{\text{total energy input}}$ Efficiency can be expressed in ratio or percentage terms.

Module P2: Living For The Future (Energy Resources)

Item P2c: Global warming

Summary: There is a large amount of discussion amongst scientists, politicians and the general public about the reasons for increased global warming. The greenhouse effect is considered to be a proven scientific explanation, but there are ongoing arguments about whether global warming is happening at all, and if it is happening, whether human activity is significantly influencing the process. This item provides a rich context in which to explore the importance of rigorous, evidence based scientific processes, and the need to effectively communicate complex scientific issues to the wider population.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
	Understand that some gases in the Earth's atmosphere prevent heat from radiating into space. Recall and recognise that this is known as the greenhouse effect.
Compare temperature changes inside sealed transparent containers with different gases inside.	Recall and identify examples of greenhouse gases to include: • carbon dioxide • water vapour • methane.
Discuss the advantages and disadvantages of using fossil fuels for making electricity. Discuss the possible consequences of global warming.	Describe reasons for climate change caused by increased global warming: • increased energy use • increased CO_2 emissions • deforestation.
Find out about the evidence for global warming in the last 200 years.	Describe the difficulties of measuring global warming. Explain why scientists working on global warming should allow other scientists to use their data.

Module P2: Living For The Future (Energy Resources)

Item P2c: Global warming

Links to other items: C1a: Making crude oil useful, B2g: Population and pollution, P2a: Collecting energy from the sun, P2b: Generating electricity, P2e: Nuclear radiations

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how electromagnetic radiation at most wavelengths can pass through the Earth's atmosphere, but certain wavelengths, particularly infrared, are absorbed by some gases in the atmosphere. Recall and identify natural and man-made sources of greenhouse gases (limited to water vapour, carbon dioxide and methane).	Explain the greenhouse effect in terms of: • short wavelength e-m radiation from the Sun is absorbed by and heats the Earth • the Earth radiates heat as longer wavelength infrared radiation • greenhouse gases absorb some infrared radiation, warming the atmosphere. Interpret data about the abundance and relative impact of greenhouse gases (limited to water vapour, carbon dioxide and methane).
Explain how human activity and natural phenomena both have effects on weather patterns including dust in the atmosphere: • from factories reflecting radiation from the city back to Earth causing warming • from volcanic ash and gases reflecting radiation from the Sun back into space causing cooling.	Interpret data about increased global warming and climate change as a result of natural or human activity (no recall is expected).
Describe scientific evidence which supports or refutes the idea of man-made global warming. Distinguish between opinion and evidence based statements in the context of the global warming debate.	Explain how it is possible to have good agreement between scientists about the greenhouse effect, but disagreement about whether human activity is affecting global warming.

Module P2: Living For The Future (Energy Resources)

Item P2d: Fuels for power

Summary: The heat energy for our power stations comes from a variety of sources. This unit considers the economic and environmental costs of the different sources we use today.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Measure the energy released by a fossil fuel by using a candle to heat water. Build a model digester to generate methane from biomass. Use software to find out or model how a nuclear power station operates.	Recall that fuels release energy as heat. Recall the common fuels used in power stations: • fossil fuels • renewable biomass – wood, straw and manure • nuclear fuels – uranium and sometimes plutonium.
Examine the use of an electricity meter or joule meter to measure energy transfer. Find out about the cost of electricity at different times of the day. Find out about the power of different electrical appliances. Research the use of electricity in their own home e.g. units used and power ratings. Research the efficiency rating of fridges, freezers washing machines and light bulbs. Research and explore how the demand for electricity is managed in the National Grid now and how this may change in the future.	Recall that the unit of power is the watt or kilowatt. Interpret data to show that the cost of using expensive electrical appliances depends on: • power rating in watts and kilowatts • the length of time it is switched on. Calculate the power rating of an appliance using the equation: power = voltage × current
Research the National Grid. Demonstrate a model transmission line system with resistance wires and a pair of transformers.	Recall that transformers can be used to increase or decrease voltage.

Module P2: Living For The Future (Energy Resources)

Item P2d: Fuels for power

Links to other items: C1a: Making crude oil useful, P2b: Generating electricity, P2e: Nuclear radiations

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe and evaluate the advantages and disadvantages of different energy sources; factors to include availability, risks and environmental impact.	
Calculate the power rating of an appliance using the equation, including conversion of power between watts and kilowatts: power = voltage × current State that the unit of electrical energy supplied is the kilowatt hour. Calculate the number of kilowatt hours given the: • power in kilowatts • time in hours. Use the equation: energy supplied = power × time Calculate the cost of energy supplied.	Use and manipulate the equation: power = voltage × current Use the kilowatt hour as a measure of the energy supplied. Use the equation: energy supplied = power × time to calculate: • power in kW or W • time in hours. Describe the advantages and disadvantages (for consumers and producers) of using off-peak electricity in the home.
Explain why transformers are used in the National Grid to increase the voltage: • electrical energy is transmitted at high voltage to reduce energy waste and costs.	Explain how, for a given power transmission, an increased voltage reduces current, so decreasing energy waste by reducing heating of cables.

Module P2: Living For The Future (Energy Resources)

Item P2e: Nuclear radiations

Summary: Most people know that radioactivity can be dangerous, but do not understand why. This item develops ideas about the uses of radioactivity, the nature of ionising radiations and how to handle their sources safely.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
	Recognise examples where nuclear radiation can be beneficial or harmful: • state one example of a beneficial use • harmful effect: damages living cells/causes cancer. Understand that radioactive materials give out nuclear radiation over time.
Teacher to use radiation detectors to show the ionising properties of nuclear radiation. Show the differing ranges and penetrating powers of alpha, beta and gamma radiation. Research how to handle radioactive sources safely. Research how nuclear radiation can damage workers if proper safety precautions are not taken. Debate the risks and benefits of using radioactive materials.	Recall the three types of nuclear radiation: • alpha • beta • gamma. Understand that nuclear radiation causes ionisation and this is potentially harmful.
Demonstrate the safety measures to be taken when handling radioactive sources after identifying appropriate risk and hazard assessments. Do research to find out how radioactive waste from nuclear power stations is disposed of.	Describe how to handle radioactive materials safely: • protective clothing • tongs / keep your distance • short exposure time • shielded and labelled storage. Describe waste from nuclear power as: • radioactive • harmful • not causing global warming.

Module P2: Living For The Future (Energy Resources)

Item P2e: Nuclear radiations

Links to other items: P2d: Fuels for power

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe examples of beneficial uses of radiation: • alpha – smoke detectors • beta – some tracers and paper thickness gauges • gamma – treating cancer, non-destructive testing, tracers and sterilising equipment.	
Describe the relative penetrating power of alpha, beta and gamma: • alpha stopped by a few sheets of paper • beta stopped by a few mm of aluminium • gamma mostly stopped by a few cm of lead. Understand that nuclear radiation can form positive ions when electrons are lost from atoms. Understand that nuclear radiation can form negative ions when electrons are gained by atoms.	Interpret data and describe experiments that show how alpha, beta and gamma can be identified by their relative penetrating powers. Understand that ionisation can initiate chemical reactions. Explain how ionisation can damage human cells.
Recall that uranium is a non-renewable resource. Recall that plutonium: • is a waste product from nuclear reactors • can be used to make nuclear bombs. Describe some ways of disposing of radioactive waste e.g.: • low level waste in land-fill sites • encased in glass and left underground • reprocessed.	Describe the advantages and disadvantages of nuclear power. Explain the problems of dealing with radioactive waste: • remains radioactive for a long time • terrorist risk • must be kept out of groundwater • acceptable radioactivity level may change over time.

Module P2: Living For The Future (Energy Resources)

Item P2f: Exploring our Solar System

Summary: When we look at the night sky, we can sometimes see the Moon, artificial satellites, planets in our Solar System and the billions of stars which make up the Universe. This item discusses the problems involved in visiting other parts of the Solar System.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Build or make a scale model of the Solar System and then work out where the nearest star would be on the same scale. You are a travel agent. Produce a brochure for aliens who might visit our Solar System.	Identify the relative positions of the Earth, Sun and planets (includes the order of the planets). Recall that the Universe consists of: • stars and planets • comets and meteors • black holes • large groups of stars called galaxies. Explain why stars give off their own light and can be seen or detected even though they are far away.
Research the exploration of the Moon by the Apollo missions. Research the problems of manned space travel. Design a manned mission to Mars. Research and debate the advantages and disadvantages of space exploration (which is very costly to several nations).	Recall that radio signals take a long time to travel through the Solar System.
Research the exploration of our Solar System by robot spacecraft. Evaluate reasons why we might need to explore our Solar System. Debate the advantages and disadvantages of using robot spacecraft to explore the Solar System.	Compare the resources needed by manned and unmanned spacecraft. Describe why unmanned spacecraft are sent into space.

Module P2: Living For The Future (Energy Resources)

Item P2f: Exploring our Solar System

Links to other items: P2g: Threats to Earth

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall the relative sizes and nature of planets, stars, comets, meteors, galaxies and black holes.	Recall that circular motion requires a centripetal force. Understand that gravitational attraction provides the centripetal force for orbital motion.
Describe a light-year as the distance light travels in a year. Describe some of the difficulties of manned space travel between planets.	Explain why a light-year is a useful unit for measuring very large distances in space.
Recall that unmanned spacecraft can withstand conditions that are lethal to humans. Compare how information from space is returned to Earth from different distances: • distant planets require data to be sent back • nearby samples can be brought back to Earth for analysis.	Explain the advantages and disadvantages of using unmanned spacecraft to explore the Solar System.

Module P2: Living For The Future (Energy Resources)

Item P2g: Threats to Earth

Summary: Most people ignore the threat of asteroid collision to the Earth. This item shows that the threat is real and has proved to be lethal many times in the past. Strategies for avoiding such catastrophes are explored.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Discuss the evidence for the presence of the Moon as the result of a collision between the Earth and another planet.	Understand that the Moon may be the remains of a planet which collided with the Earth billions of years ago.
Research the evidence for the extinction of the dinosaurs by an asteroid. Research and debate other theories for the extinction of dinosaurs. Discuss how the surface of the Moon provides evidence for the continual bombardment of the Earth by asteroids.	Recall that large asteroids have collided with the Earth in the past. Recall that asteroids are rocks. Describe some of the consequences of a collision with a large asteroid: • crater • ejection of hot rocks • widespread fires • sunlight blocked by dust • climate change • species extinction.
Research the history of Halley's comet. Research the exploration of comets by robot spacecraft. Discuss the collision of a comet with Jupiter.	Describe the make up of a comet: • made from ice and dust • has a tail formed from a trail of debris.
Debate the importance of funding telescopes to search for Near Earth Objects. Design a plan to deal with the threat of an asteroid collision.	Describe a Near Earth Object (NEO) as an asteroid or comet on a possible collision course with Earth. Describe how NEOs may be seen.

Module P2: Living For The Future (Energy Resources)

Item P2g: Threats to Earth

Links to other items: P2f: Exploring our Solar System

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how a collision between two planets can result in an Earth-Moon system: • the planets collide • their iron cores merge to form the core of the Earth • less dense material orbits as the Moon.	Discuss the evidence for the Earth-Moon system as the result of a collision between two planets.
Describe asteroids: • as being left over from the formation of the Solar System • as being in orbit between Mars and Jupiter. Describe some of the evidence for past asteroid collisions: • layers of unusual elements in rocks • sudden changes in fossil numbers between adjacent layers of rock.	Explain why the asteroid belt is between Mars and Jupiter: • the gravitational attraction of Jupiter disrupts the formation of a planet.
Describe comets: • as having highly elliptical orbits • as coming from objects orbiting the Sun far beyond the planets. Describe how the speed of a comet changes as it approaches a star.	Explain in terms of changing gravitational attraction, why the speed of a comet changes as it approaches a star.
Describe how observations of NEOs can be used to determine their trajectories. Explain why it is difficult to observe NEOs.	Suggest and discuss possible actions which could be taken to reduce the threat of NEOs: • surveys by telescope • monitoring by satellites • deflection by explosions (when they are distant enough from Earth).

Module P2: Living For The Future (Energy Resources)

Item P2h: The Big Bang

Summary: There are a number of theories about how the Universe was formed and how it will continue to evolve. This item develops ideas about the evolution of the Universe and its possible future. The Big Bang theory is considered.

Suggested practical and research activities to select from	Assessable learning outcomes Foundation Tier only: low demand
Explore examples of the Doppler effect e.g. passing police siren, whirling a buzzer round on a string. Research Doppler simulations on PowerPoint. Build a model of the expanding Universe with a balloon to show that spots on the surface are moving faster and further away from each other as the balloon is inflated. Draw a time line for the age of the Universe. Discuss ideas about the origin of the Universe.	Describe some ideas about the Big Bang theory for the origin of the Universe: • started with an explosion • the Universe is still expanding.
Discuss ideas about the birth and death of stars. Research the evidence for the black hole at the centre of the Milky Way. Research and debate different models (scientific and non-scientific) which attempt to explain the start of the Universe.	Recall that stars: • have a finite 'life' • start as a huge gas cloud • are different sizes. Understand why not even light can escape from black holes.
Produce a timeline for changing models of the Universe.	Recognise that the accepted models of the size and shape of the Universe have changed over time. Describe and recognise the Ptolemaic and Copernican models of the Universe, and describe how they differ from each other and the modern day model.

Module P2: Living For The Future (Energy Resources)

Item P2h: The Big Bang

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that: • most galaxies are moving away from us • distant galaxies are moving away more quickly • microwave radiation is received from all parts of the Universe.	Explain how the Big Bang theory accounts for: • light from other galaxies shifting to the red end of the spectrum • more distant galaxies generally showing greater red shift • estimating the age and starting point of the Universe.
Describe the end of the 'life cycle' of a small star: • red giant • planetary nebula • white dwarf. Describe the end of the 'life cycle' of a large star: • red supergiant • supernova • neutron star or black hole (for massive stars).	Describe the life history of a star: • interstellar gas cloud • gravitational collapse producing a proto star • thermonuclear fusion • long period of normal life (main sequence) • end depends on mass of star. Explain the properties of a black hole: • large mass, small volume and high density • strong gravitational attraction due to the large mass.
Describe the evidence or observations that caused Copernicus and Galileo to develop new scientific models of the Universe, and explain how technological advances contributed to the new models.	Explain why the theories of the Copernicus and Galileo models were considered controversial when they were announced, and were not widely adopted until many years had passed.

4 Assessment of GCSE Science B

4.1 Overview of the assessment in GCSE Science B

To claim the qualification GCSE Science B (J261) candidates must complete units B711, B712 and B713.

GCSE Science B J261	
Unit B711: *Science modules B1, C1, P1*	
35% of the total GCSE 1 hour 15 mins written paper 75 marks	This question paper: • is offered in Foundation and Higher Tiers • focuses on modules B1, C1 and P1 • uses structured questions (candidates answer all questions) • assesses the quality of written communication.
Unit B712: *Science modules B2, C2, P2*	
40% of the total GCSE 1 hour 30 mins written paper 85 marks	This question paper: • is offered in Foundation and Higher Tiers • focuses on modules B2, C2 and P2 • includes a 10 mark data response section which assesses AO3 (analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence) • uses structured questions (candidates answer all questions) • assesses the quality of written communication.
Unit B713: *Science controlled assessment*	
25% of the total GCSE Controlled assessment Approximately 6 hours 48 marks	This unit: • comprises one assessment task, split into three parts • is assessed by teachers, internally standardised and then externally moderated by OCR • assesses the quality of written communication.

4.2 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 B711 and B712, candidates are entered for an option in either the Foundation Tier or the Higher Tier. Unit B713 (controlled assessment) is 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 B711/F and B712/H.

4.3 Assessment objectives (AOs)

Candidates are expected to demonstrate their ability to:

AO1	recall, select and communicate their knowledge and understanding of science
AO2	apply skills, knowledge and understanding of science in practical and other contexts
AO3	analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence.

4.3.1 AO weightings – GCSE Science B

The relationship between the units and the assessment objectives of the scheme of assessment is shown in the following grid:

Unit	% of GCSE			
	AO1	AO2	AO3	Total
Unit B711: *Science modules B1, C1, P1*	16	17.5	1.5	35
Unit B712: *Science modules B2, C2, P2*	16	17.5	6.5	40
Unit B713: *Science controlled assessment*	2	5	18	25
Total	34	40	26	100

4.4 Grading and awarding grades

GCSE results are awarded on the scale A* to G. Units are awarded a* to g. Grades are indicated on certificates. However, results for candidates who fail to achieve the minimum grade (G or g) will be recorded as *unclassified* (U or u) and this is **not** certificated.

Most GCSEs are unitised schemes. When working out candidates' overall grades OCR needs to be able to compare performance on the same unit in different series when different grade boundaries may have been set, and between different units. OCR uses a Uniform Mark Scale to enable this to be done.

A candidate's uniform mark for each unit is calculated from the candidate's raw mark on that unit. The raw mark 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. 60/100.

The specification is graded on a Uniform Mark Scale. The uniform mark thresholds for each of the assessments are shown below:

(GCSE) Unit Weighting	Maximum Unit Uniform Mark	Unit Grade								
		a*	a	b	c	d	e	f	g	u
25%	100	90	80	70	60	50	40	30	20	0
35% F	97	–	–	–	84	70	56	42	28	0
35% H	140	126	112	98	84	70	63	–	–	0
40% F	111	–	–	–	96	80	64	48	32	0
40% H	160	144	128	112	96	80	72	–	–	

Higher Tier candidates who fail to gain a 'd' grade may achieve an "allowed e". Higher Tier candidates who miss the allowed grade 'e' will be graded as 'u'.

A candidate's uniform marks for each unit are aggregated and grades for the specification are generated on the following scale:

Qualification	Max Uniform Mark	Qualification Grade								
		A*	A	B	C	D	E	F	G	U
GCSE	400	360	320	280	240	200	160	120	80	0

The written papers will have a total weighting of 75% and controlled assessment a weighting of 25%.

A candidate's uniform mark for each paper will be combined with the uniform mark for the controlled assessment to give a total uniform mark for the specification. The candidate's grade will be determined by the total uniform mark.

4.5 Grade descriptions

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The descriptions must be interpreted in relation to the content in the specification; they are not designed to define that content. 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 candidates' performance in the assessment may be balanced by better performance in others.

The grade descriptors have been produced by the regulatory authorities in collaboration with the awarding bodies.

4.5.1 Grade F

Candidates recall, select and communicate their limited knowledge and understanding of science. They have a limited understanding that scientific advances may have ethical implications, benefits and risks. They recognise simple inter-relationships between science and society. They use limited scientific and technical knowledge, terminology and conventions, showing some understanding of scale in terms of time, size and space.

They apply skills, including limited communication, mathematical and technological skills, knowledge and understanding in practical and some other contexts. They show limited understanding of the nature of science and its applications. They can explain straightforward models of phenomena, events and processes. Using a limited range of skills and techniques, they answer scientific questions, solve straightforward problems and test ideas.

Candidates interpret and evaluate some qualitative and quantitative data and information from a limited range of sources. They can draw elementary conclusions having collected limited evidence.

4.5.2 Grade C

Candidates recall, select and communicate secure knowledge and understanding of science. They demonstrate understanding of the nature of science, its laws, its applications and the influences of society on science and science on society. They understand how scientific advances may have ethical implications, benefits and risks. They use scientific and technical knowledge, terminology and conventions appropriately, showing understanding of scale in terms of time, size and space.

They apply appropriate skills, including communication, mathematical and technological skills, knowledge and understanding in a range of practical and other contexts. They recognise, understand and use straightforward links between hypotheses, evidence, theories, and explanations. They use models to explain phenomena, events and processes. Using appropriate methods, sources of information and data, they apply their skills to answer scientific questions, solve problems and test hypotheses.

Candidates analyse, interpret and evaluate a range of quantitative and qualitative data and information. They understand the limitations of evidence and develop arguments with supporting explanations. They draw conclusions consistent with the available evidence.

4.5.3 Grade A

Candidates recall, select and communicate precise knowledge and detailed understanding of science. They demonstrate a comprehensive understanding of the nature of science, its laws, its applications, and the influences of society on science and science on society. They understand the relationships between scientific advances, their ethical implications and the benefits and risks associated with them. They use scientific and technical knowledge, terminology and conventions appropriately and consistently showing a detailed understanding of scale in terms of time, size and space.

They apply appropriate skills, including communication, mathematical and technological skills, knowledge and understanding effectively in a wide range of practical and other contexts. They show a comprehensive understanding of the relationships between hypotheses, evidence, theories and explanations and make effective use of models to explain phenomena, events and processes. They use a wide range of appropriate methods, sources of information and data consistently, applying relevant skills to address scientific questions, solve problems and test hypotheses.

Candidates analyse, interpret and critically evaluate a broad range of quantitative and qualitative data and information. They evaluate information systematically to develop arguments and explanations taking account of the limitations of the available evidence. They make reasoned judgments consistently and draw detailed, evidence-based conclusions

4.6 Quality of written communication

Quality of written communication is assessed in all units and is integrated in the marking criteria.

Candidates are expected to:

- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
- present information in a form that suits its purpose
- use an appropriate style of writing and, where applicable, specialist terminology.

Questions assessing quality of written communication will be indicted by a pencil icon (✎).

Controlled assessment in GCSE Science B

5

This section provides general guidance on controlled assessment: what controlled assessment tasks are, when and how they are available; how to plan and manage controlled assessment and what controls must be applied throughout the process. More specific guidance and support is provided in the *Guide to controlled assessment* for GCSE Gateway Science B, available on the OCR website.

Teaching and Learning

Controlled assessment is designed to be an integral part of teaching and learning. There are many opportunities in teaching and learning to develop skills and use a variety of appropriate materials and equipment. These opportunities allow students to practise a wide range of tasks, and teachers can discuss and comment on performance as appropriate.

When all necessary teaching and learning has taken place and teachers feel that candidates are ready for assessment, candidates can be given the appropriate controlled assessment task.

5.1 Controlled assessment tasks

All controlled assessment tasks are set by OCR, are published on Interchange, and may only be submitted in the June examination series. Each year a choice of three tasks will be valid for submission. The number of tasks attempted by a candidate is at the discretion of the centre, but the results of only one may be submitted.

Each task will be valid for submission in a single examination series only. This will be clearly marked on the front cover of each task. Centres must ensure that candidates undertake a task applicable to the required year of submission by checking carefully the examination dates of the tasks on Interchange. Tasks will not be valid for submission in any examination series other than that indicated.

Each year, three new controlled assessment tasks will be made available on Interchange from 1st June for certification in the following academic year, two years ahead of the examination series for which the tasks are to be submitted. Tasks will be removed upon expiry. Guidance on how to access controlled assessment tasks from Interchange is available on the OCR website: www.ocr.org.uk.

The same OCR controlled assessment task must **NOT** be used as practice material and then as the actual live assessment material.

5.2 Nature of controlled assessment tasks

5.2.1 Introduction to controlled assessment

Controlled assessment tasks have been designed to be an integral part of the teaching of the course. The practical activities will be based on the specification content. It is expected that candidates will complete the task at the appropriate point in the teaching of the specification content.

Opportunities to develop the practical skills required for this task are highlighted in the content of the specification. It is essential that candidates have some advance practice in these skills so that they can maximise their attainment. Candidates will need to take part in a planned learning programme that covers the underpinning knowledge and skills of the unit prior to undertaking the task.

The controlled assessment unit requires the completion of one assessment task. Each task is divided into three parts which are linked into an overall theme. The three parts should be taken in the order of Part 1, Part 2 and Part 3. Stimulus material will be provided which will introduce candidates to the task and direct the work they produce.

Part 1 – Research and collecting secondary data

Part 1 requires candidates to plan and carry out research. The Part 1 stimulus material introduces the task and provides guidance for the research. The research may be conducted either in class or as a homework exercise. The information collected is required for Parts 2 and 3.

Part 2 – Planning and collecting primary data

Part 2 requires candidates to plan and carry out an investigation to collect primary data to test a hypothesis stated in the Part 2 stimulus material. Collecting the data, as well as an assessed skill, will help candidates in Part 3 of the task by:

- enhancing their awareness of the practical techniques involved
- focusing on the quality of the data collected
- making them aware of the risks and necessary safety precautions.

Part 3 – Analysis and evaluation

Part 3 requires candidates to process and analyse the results from their research (Part 1) and their primary data (Part 2). They will also be required to evaluate their data and the methods used to collect it, and draw and justify a conclusion. Candidates will be guided by questions in an answer booklet.

5.2.2 Summary of task in Unit B713

Assessment Task	Task Marks	Weighting
Science controlled assessment task (Part 1, Part 2 and Part 3)	48	25%

5.3 Planning and managing controlled assessment

Controlled assessment tasks are available at an early stage to allow planning time prior to delivery. It is anticipated that candidates will spend a total of about 6 hours in producing the work for this unit. Candidates should be allowed sufficient time to complete the tasks.

While the wording of the stimulus material and questions must remain unchanged, practical aspects of these tasks can be adapted so that they allow the use of resources available to the centre, including the availability of equipment and materials for practical work.

Where controlled assessment tasks are adapted by centres this must be in ways that will not put at risk the opportunity for candidates to meet the Marking Criteria, including the chance to gain marks at the highest level.

Suggested steps and timings are included below, with guidance on regulatory controls at each step of the process. Teachers must ensure that control requirements indicated below are met throughout the process.

The parts of the task should be taken in the order of Part 1, Part 2 and Part 3. Candidates' work for Parts 1 and 2 should be collected on completion and returned to the candidates for Part 3.

5.3.1 Part 1 – Research and collecting secondary data

- Research activities **1.5 – 2 hours**

The teacher should introduce Part 1 of the task, including time allocations, an outline of the task, the methods of work, control requirements and deadlines. The teacher may introduce the stimulus material to be used in Part 1.

In Part 1, the research stage, a limited level of control is required. Candidates can undertake the research part of the process without direct teacher supervision. Candidates should be provided with access to resources and materials which allow them to access the full range of marking criteria. The work of individual candidates may be informed by working with others; however, candidates must produce an individual response for use in the Part 2 and Part 3 supervised sessions. During the research stage candidates can be given support and guidance. They should be provided with the stimulus which provides the topic for the research. Teachers can explain the task, advise on how the task could be approached, and advise on resources.

Research methods can include fieldwork, internet or paper-based research, questionnaires, audio and video files etc. It is essential that any material directly used from a source is appropriately and rigorously referenced. Further advice and guidance regarding the research stage is provided in the *Guide to controlled assessment* for GCSE Gateway Science B. Research activities can be lesson or homework time.

At the end of Part 1, candidates will have individually written up their research and collected their research data. This should be collected in and retained by the teacher and returned to the candidate when completing Part 2 and Part 3.

5.3.2 Part 2 – Planning and collecting primary data

- Planning **1 hour**
- Practical **1 hour**

The teacher should introduce Part 2 of the task, including time allocations, an outline of the task, the methods of work, control requirements and deadlines. The teacher may introduce the stimulus material to be used in Part 2. Candidates also need access to their individual work and research from Part 1.

In Part 2 candidates are required to plan an investigation to test a given hypothesis, provide a risk assessment of their plan and carry out the experiment they have planned to collect primary data. Candidates may work in groups of no more than three to develop the plan and carry out the investigation. However, candidates' plan and results must be recorded individually in supervised lesson time.

Teachers should supervise the practical work in accordance with normal practice, to ensure safety procedures (see Appendix D for further guidance). Guidance regarding levels of support is provided in the *Guide to controlled assessment* for GCSE Gateway Science B. This includes guidance on adapting the tasks for the equipment and materials available to the centre. Candidates will need to be provided with materials and equipment to allow them to access the full range of the marking criteria. Further specific guidance will also be provided with each task.

The work of candidates should be collected in and retained by the teacher and returned to the candidate when completing Part 3.

5.3.3 Part 3 – Analysis and evaluation

- Analysis and evaluation **1.5 – 2 hours**

The teacher should introduce Part 3 of the task, including time allocations, an outline of the task, the methods of work, control requirements and deadlines. The teacher may introduce the answer booklet to be used in Part 3.

In Part 3 candidates must work independently under supervised conditions as this part is under high control.

The answer booklet for Part 3 requires candidates to process and analyse the secondary data and information they have collected (Part 1) and the results of their investigation (Part 2). Candidates will need access to their individual responses from Part 1 and Part 2. Questions then guide candidates to evaluate their data and the methods used to collect it, and draw and justify a conclusion.

In processing the data candidates will have opportunities to use mathematical and graphical skills. Candidates must not be instructed or advised in these areas during the task.

On completion of the task, the loose leaf pages for Parts 1 and 2 should be collated and attached to each candidate's Part 3 answer booklet.

5.3.4 Supervision by the teacher

Candidates must work individually under limited supervision to:

- record their findings from secondary research in Part 1
- record their experimental plan and risk assessment in Part 2
- record their experimental results in Part 2.

Candidates must work independently under supervised conditions to:

- complete the answer booklet in Part 3.

The work submitted for moderation must be produced under controlled conditions, which means under teacher supervision: teachers must be able to authenticate the work and the candidates must acknowledge and reference any sources used. As writing up of each part is carried out over several sessions, work must be collected in between sessions. The Part 2 stimulus material and Part 3 answer booklet must not be taken out of the supervised sessions.

When supervising tasks, teachers are expected to:

- exercise continuing supervision of work in order to monitor progress and to prevent plagiarism
- provide guidance on the use of information from other sources to ensure that confidentiality and intellectual property rights are maintained
- exercise continuing supervision of practical work to ensure essential compliance with Health and Safety requirements
- ensure that the work is completed in accordance with the specification requirements and can be assessed in accordance with the specified marking criteria and procedures.

Teachers must not provide templates, model answers or feedback on drafts. They may give generic, informal feedback while the task is being completed but may not indicate what candidates need to do to improve their work.

5.3.5 Presentation of the work

Candidates must observe the following procedures when producing their final piece of work for the controlled assessment tasks:

- responses to Parts 1 and 2 will be on loose leaf paper. Tables and graphs may be produced using appropriate ICT. These should all be attached to the answer booklet for Part 3
- any copied material must be suitably acknowledged
- quotations must be clearly marked and a reference provided wherever possible
- work submitted for moderation must be marked with the:
  - centre number
  - centre name
  - candidate number
  - candidate name
  - unit code and title
  - task title.

Work submitted on paper for moderation must be secured by treasury tags. Work submitted in digital format (CD or online) must be in a suitable file structure as detailed in Appendix A at the end of this specification.

5.4 Marking and moderating controlled assessment

All controlled assessment tasks are marked by centre assessor(s) using OCR marking criteria and guidance.

This corresponds to a medium level of control.

5.4.1 Applying the marking criteria

The starting point for marking the tasks is the marking criteria (see Section 5.4.4 *Marking criteria for controlled assessment tasks* below). The criteria identify levels of performance for the skills, knowledge and understanding that the candidate is required to demonstrate. Additional guidance for each task will be provided alongside the generic marking criteria. At INSET training events and in support materials, OCR will provide exemplification through real or simulated candidate work which will help to clarify the level of achievement that assessors should be looking for when awarding marks.

5.4.2 Use of 'best fit' approach to the application of the marking criteria

A controlled assessment task should only be marked when all three parts have been completed. The task should be marked by teachers according to the marking criteria using a 'best fit' approach. For each of the skill qualities, teachers should first use their professional judgement to select one of the four band descriptors provided in the marking grid that most closely describes the quality of the work being marked.

Following the selection of the band descriptor, the most appropriate mark within the band descriptor is chosen. Teachers should use the following guidance to select this mark:

- where the candidate's work *convincingly* meets the statement, the higher mark should be awarded (for example the 3 – 4 marks band is chosen and 4 marks are awarded)
- where the candidate's work *just* meets the statement, the lower mark should be awarded (for example the 3 – 4 marks band is chosen and 3 marks are awarded).

Marking should be positive, rewarding achievement rather than penalising failure or omissions. The award of marks **must be** directly related to the marking criteria.

Teachers should use the full range of marks available to them and award *full* marks in any band for work which fully meets that descriptor. This is work which is 'the best one could expect from candidates working at that level'.

The final mark for the candidate for the controlled assessment unit is out of a total of 48 and is found by totalling the marks for each skill quality. Only one mark out of a total of 48 will be required for submission for the unit.

There should be clear evidence that work has been attempted and some work produced. If a candidate submits no work for the internally assessed unit, then the candidate should be indicated as being absent from that unit. If a candidate completes any work at all for an internally assessed unit, then the work should be assessed according to the marking criteria and the appropriate mark awarded, which may be zero.

5.4.3 Annotation of candidates' work

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

The writing of comments on candidates' work provides a means of communication between teachers during the internal standardisation and with the moderator if the work forms part of the moderation sample.

5.4.4 Marking criteria for controlled assessment tasks

Assessment objectives (AOs)

Each of the aspects to be assessed addresses one or more of the assessment objectives and these are shown in the marking criteria. The overall balance is shown in the table below.

Assessment objective		Total
AO1:	Recall, select and communicate their knowledge and understanding of science	5
AO2:	Apply skills, knowledge and understanding of science in practical and other contexts	11
AO3:	Analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence	32
	Total	**48**

Assessment of the quality of written communication

The quality of written communication is assessed in Parts 2 and 3 of this controlled assessment and indicated by a pencil symbol (✎) for the information of candidates.

Skill quality	1 – 2 marks	3 – 4 marks	5 – 6 marks	AO
Researching: collect secondary data including the use of appropriate technology.	Some information collected and used from at least two sources.	Relevant information collected from at least three sources; information presented clearly and all sources identified.	Range of relevant sources identified and judgement used to select those appropriate to the task. Information collated and presented clearly in appropriate formats including a full bibliography.	AO1 – 1 AO2 – 3 AO3 – 2
Planning: plan practical ways to answer scientific questions and test hypotheses; devise appropriate methods for the collection of numerical and other data.	Outline plan includes equipment and techniques to be used. Plan provides a 'fair test'. No evidence of modifications of plan during the data collection phase. Plan shows limited structure with errors in spelling and punctuation.	Plan gives sufficient detail for experiment to be repeated, including choices of: equipment and techniques; range and number of data points for the independent variable; number of replicates; other variables to be controlled with the aim of collecting quality data. Some consideration given to how errors will be minimised. No evidence of modifications of plan during the data collection phase. Plan structured clearly with occasional errors in spelling and punctuation.	Comprehensive plan shows scientific understanding in making appropriate choices of: equipment, including resolution, and techniques; range and number of data points for the independent variable; number of replicates; control of all other variables, with the aim of collecting accurate data. Detailed consideration given to: how errors will be minimised; variables which cannot be controlled. Where appropriate, reasoned modifications made to the plan as evidence is collected. Plan structured coherently with few, if any, errors in grammar, punctuation and spelling.	AO1 – 1 AO2 – 4 AO3 – 1
Collecting data: collect primary data including the use of appropriate technology.	Results recorded clearly but not in an appropriate format.	Results tabulated to include all data expected, though not in the most appropriate format. Headings given but units not always correct.	Results tabulated clearly and logically, including use of correct headings and units; all data expected recorded to appropriate levels of precision.	AO1 – 2 AO2 – 4

* 0 marks = no response or no response worthy of credit.

Managing risk: assess and manage risks when carrying out practical work.	Limited understanding of risks in procedures with only standard laboratory safety features mentioned. Some teacher intervention required to ensure safety.	Some risks in procedures analysed and some specific responses suggested to reduce risks. Risks managed successfully with no significant incidents or accidents and no requirement for teacher intervention.	All significant risks in the plan evaluated. Reasoned judgments made to reduce risks by use of appropriate specific responses. Risks managed successfully with no incidents or accidents and no requirement for teacher intervention.	AO3 – 6
Processing data: process primary and secondary data including the use of appropriate technology.	Some evidence of processing quantitative data: data presented as simple charts or graphs with some errors in scaling or plotting; use of one simple mathematical technique.	Graphical and mathematical techniques used to reveal patterns in the data: charts or graphs used to display data in an appropriate way, allowing some errors in scaling or plotting; correct use of more than one simple mathematical technique.	Appropriate graphical and mathematical techniques used to reveal patterns in the data: type of graph, scales and axes selected and data plotted accurately, including where appropriate a line of best fit; correct use of complex mathematical techniques where appropriate; appropriate quantitative treatment of level of uncertainty of data.	AO3 – 6
Analysing and interpreting: analyse and interpret primary and secondary data.	At least one trend/pattern identified and outlined correctly; an attempt is made to interpret the information linking primary and secondary data/information.	Main trend(s)/pattern(s) described and interpreted with reference to quantitative data and scientific knowledge and understanding, with some errors; reasoned comparison between primary and secondary data/information; any anomalous results identified correctly and implications discussed.	All trend(s)/pattern(s) described and interpreted correctly with reference to quantitative data and relevant scientific knowledge and understanding; links between primary and secondary data/ information evaluated; level of uncertainty of the evidence analysed.	AO3 – 6

* 0 marks = no response or no response worthy of credit.

Skill quality	1 – 2 marks	3 – 4 marks	5 – 6 marks	AO
Evaluating: evaluate methods of data collection and the quality of the resulting data.	Relevant comments made about the quality of the data and the method used. Answer is simplistic with limited use of specialist terms.	Comments made on the quality of the data including accuracy and sources of error, linked to the method of collection; limitations in the method of data collection identified and suggestions for improvement given. Information is relevant and presented in a structured format. Specialist terms are for the most part used appropriately.	Detailed and critical consideration given to the data and methods used to obtain them: sources of error and quality of the data discussed and explained, including accuracy, repeatability and uncertainty; limitations of the method identified and suggestions for improvements justified. Information is relevant, clear, organised and presented in a coherent format. Specialist terms are used appropriately.	AO1 – 1 AO3 – 5
Justifying a conclusion: draw evidence-based conclusions.	Conclusion given using the data collected. Answers simplistic with little scientific understanding.	Conclusion given and justified based on an analysis of the data and information from research and investigation, demonstrating an understanding of the underpinning science.	Conclusion given and justified based on a critical analysis of the data and information from research and investigation, and clearly linked to relevant scientific knowledge and understanding.	A03 – 6

* 0 marks = no response or no response worthy of credit.

5.4.5 Authentication of work

Teachers must be confident that the work they mark is the candidate's own. This does not mean that a candidate must be supervised throughout the completion of all work but the teacher must exercise sufficient supervision, or introduce sufficient checks, to be in a position to judge the authenticity of the candidate's work.

Wherever possible, the teacher should discuss work-in-progress with candidates. This will not only ensure that work is underway in a planned and timely manner but will also provide opportunities for assessors to check authenticity of the work and provide general feedback.

Candidates must not plagiarise. Plagiarism is the submission of another's work as one's own and/or failure to acknowledge the source correctly. Plagiarism is considered to be malpractice and could lead to the candidate being disqualified. Plagiarism sometimes occurs innocently when candidates are unaware of the need to reference or acknowledge their sources. It is therefore important that centres ensure that candidates understand that the work they submit must be their own and that they understand the meaning of plagiarism and what penalties may be applied. Candidates may refer to research, quotations or evidence but they must list their sources. The rewards from acknowledging sources, and the credit they will gain from doing so, should be emphasised to candidates as well as the potential risks of failing to acknowledge such material.

Both candidates and teachers must declare that the work is the candidate's own:

- **each candidate** must sign a declaration before submitting their work to their teacher. A candidate authentication statement that can be used is available to download from the OCR website. These statements should be retained within the centre until all enquiries about results, malpractice and appeals issues have been resolved. **A mark of zero must be recorded if a candidate cannot confirm the authenticity of their work.**
- **teachers** are required to declare that the work submitted for internal assessment is the candidate's own work by sending the moderator a centre authentication form (CCS160) for each unit at the same time as the marks. If a centre fails to provide evidence of authentication, **we will set the mark for that candidate(s) to Pending (Q) for that component until authentication can be provided.**

5.5 Internal standardisation

It is important that all internal assessors of this controlled assessment work to common standards. Centres must ensure that the internal standardisation of marks across assessors and teaching groups takes place using an appropriate procedure.

This can be done in a number of ways. In the first year, reference material and OCR training meetings will provide a basis for centres' own standardisation. In subsequent years, this, or centres' own archive material, may be used. Centres are advised to hold preliminary meetings of staff involved to compare standards through cross-marking a small sample of work. After most marking has been completed, a further meeting at which work is exchanged and discussed will enable final adjustments to be made.

5.6 Submitting marks and authentication

All work for controlled assessment is marked by the teacher and internally standardised by the centre. Marks are then submitted to OCR and your moderator: refer to the OCR website for submission dates of the marks to OCR.

There should be clear evidence that work has been attempted and some work produced. If a candidate submits no work for an internally assessed component, then the candidate should be indicated as being absent from that component. If a candidate completes any work at all for an internally assessed component, then the work should be assessed according to the internal assessment objectives and marking instructions and the appropriate mark awarded, which may be zero.

The centre authentication form (CCS160) must be sent to the moderator with the marks.

5.7 Submitting samples of candidate work

5.7.1 Sample requests

Once you have submitted your marks, your exams officer will receive an email requesting a moderation sample. Samples will include work from across the range of attainment of the candidates' work.

The sample of work which is presented to the moderator for moderation must show how the marks have been awarded in relation to the marking criteria defined in Section 5.4.4.

When making your entries, the entry option specifies how the sample for each unit is to be submitted. For each of these units, all candidate work must be submitted using the **same entry option**. It is not possible for centres to offer both options for a unit within the same series. You can choose different options for different units. Please see Section 8.2.1 for entry codes.

5.7.2 Submitting moderation samples via post

The sample of candidate work must be posted to the moderator within three days of receiving the request. You should use one of the labels provided to send the candidate work.

We would advise you to keep evidence of work submitted to the moderator, e.g. copies of written work or photographs of practical work. You should also obtain a certificate of posting for all work that is posted to the moderator.

5.7.3 Submitting moderation samples via the OCR Repository

The OCR Repository is a secure website for centres to upload candidate work and for assessors to access this work digitally. Centres can use the OCR Repository for uploading marked candidate work for moderation.

Centres can access the OCR Repository via OCR Interchange, find their candidate entries in their area of the Repository, and use the Repository to upload files (singly or in bulk) for access by their moderator.

The OCR Repository allows candidates to send evidence in electronic file types that would normally be difficult to submit through postal moderation; for example multimedia or other interactive unit submissions.

The OCR GCSE Science B unit B713 can be submitted electronically to the OCR Repository via Interchange: please check Section 8.2.1 for unit entry codes for the OCR Repository.

There are three ways to load files to the OCR Repository:

1. Centres can load multiple files against multiple candidates by clicking on 'Upload candidate files' in the Candidates tab of the Candidate Overview screen.

2. Centres can load multiple files against a specific candidate by clicking on 'Upload files' in the Candidate Details screen.

3. Centres can load multiple administration files by clicking on 'Upload admin files' in the Administration tab of the Candidate Overview screen.

The OCR Repository is seen as a faster, greener and more convenient means of providing work for assessment. It is part of a wider programme bringing digital technology to the assessment process, the aim of which is to provide simpler and easier administration for centres.

Instructions for how to upload files to OCR using the OCR Repository can be found on OCR Interchange.

5.8 External moderation

The purpose of moderation is to ensure that the standard of the award of marks for work is the same for each centre and that each teacher has applied the standards appropriately across the range of candidates within the centre.

At this stage, if necessary, centres may be required to provide an additional sample of candidate work (if marks are found to be in the wrong order) or carry out some re-marking. If you receive such a request, please ensure that you respond as quickly as possible to ensure that your candidates' results are not delayed.

6 Support for GCSE Science B

6.1 Free resources available from the OCR website

The following materials will be available on the OCR website:

- GCSE Science B Specification
- specimen assessment materials and mark schemes
- Guide to controlled assessment
- sample controlled assessment materials
- exemplar candidate work
- Teachers' Handbook
- sample schemes of work and lesson plans

Essential FREE support services including:

- INSET training – for information visit www.gcse-science.com
- Interchange – a completely secure, free website to help centres reduce administrative tasks at exam time http://www.ocr.org.uk/interchange
- e-alerts – register now for regular updates at www.ocr.org.uk/2011signup
- Active Results – detailed item level analysis of candidate results.

6.2 Other resources

OCR offers centres a wealth of high quality published support with a choice of 'Official Publisher Partner' and 'Approved Publication' resources, all endorsed by OCR for use with OCR specifications.

6.2.1 Publisher partners

OCR works in close collaboration with publisher partners to ensure you have access to:

- published support materials available when you need them, tailored to OCR specifications
- high quality resources produced in consultation with OCR subject teams, which are linked to OCR's teacher support materials

OCR RECOGNISING ACHIEVEMENT Collins FREEDOM TO TEACH

Official Publisher Partnership

Collins is the publisher partner for OCR GCSE Additional Science B.

Collins is working with a team of experienced authors to provide resources which will help you deliver the new OCR GCSE Gateway Science specifications.

- With Collins New GCSE Science you can:

Explain

- be sure you're delivering the new specification with content organised and written to match the specifications
- deliver outstanding lessons every time with differentiated lesson plans that include high quality plenaries to check effectiveness of every lesson and expert guidance on how to make a good lesson outstanding

Explore

- explore Science as it happens in the real world through interactive videos and animations in Interactive Books and How Science Works integrated throughout the series
- emphasise how science is relevant with engaging facts throughout and activities based on the book Bad Science, by Ben Goldacre

Excel

- help your students excel with plenty of practice questions that provide extra support for the quality of written communication
- raise standards with more questions than ever before designed to stretch and challenge high achievers.

6.2.2 Endorsed publications

OCR endorses a range of publisher materials to provide quality support for centres delivering its qualifications. You can be confident that materials branded with OCR's 'Official Publishing Partner' or 'Approved publication' logos have undergone a thorough quality assurance process to achieve endorsement. All responsibility for the content of the publisher's materials rests with the publisher.

These endorsements do not mean that the materials are the only suitable resources available or necessary to achieve an OCR qualification.

6.3 Training

OCR will offer a range of support activities for all practitioners throughout the lifetime of the qualification to ensure they have the relevant knowledge and skills to deliver the qualification.

Please see Event Booker for further information.

6.4 OCR support services

6.4.1 Active Results

Active Results is available to all centres offering OCR's GCSE Science B specification.

activeresults

Active Results is a free results analysis service to help teachers review the performance of individual candidates or whole schools.

Data can be analysed using filters on several categories such as gender and other demographic information, as well as providing breakdowns of results by question and topic.

Active Results allows you to look in greater detail at your results:

- Richer and more granular data will be made available to centres including question level data available from e-marking.
- You can identify the strengths and weaknesses of individual candidates and your centre's cohort as a whole.
- Our systems have been developed in close consultation with teachers so that the technology delivers what you need.

Further information on Active Results can be found on the OCR website.

6.4.2 OCR Interchange

OCR Interchange has been developed to help you to carry out day-to-day administration functions online, quickly and easily. The site allows you to register and enter candidates online. In addition, you can gain immediate and free access to candidate information at your convenience. Sign up on the OCR website.

7.1 Equality Act information relating to GCSE Science B

GCSEs often require assessment of a broad range of competences. This is because they are general qualifications and, as such, prepare candidates for a wide range of occupations and higher level courses.

The revised GCSE qualification and subject criteria were reviewed by the regulators in order to identify whether any of the competences required by the subject presented a potential barrier to any disabled candidates. If this was the case, the situation was reviewed again to ensure that such competences were included only where essential to the subject. The findings of this process were discussed with disability groups and with disabled people.

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments and to demonstrate what they know and can do. For this reason, very few candidates will have a complete barrier to the assessment. Information on reasonable adjustments is found in *Access Arrangements, Reasonable Adjustments and Special Consideration* by the Joint Council www.jcq.org.uk.

Candidates who are unable to access part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award based on the parts of the assessment they have taken.

The access arrangements permissible for use in this specification are in line with Ofqual's GCSE subject criteria equalities review and are as follows:

	Yes/No	Type of Assessment
Readers	Yes	All assessments
Scribes	Yes	All assessments
Practical assistants	Yes	For controlled assessments. The practical assistant may assist with assessed practical tasks under instruction from the candidate.
Word processors	Yes	All assessments
Transcripts	Yes	All assessments
BSL interpreters	Yes	All assessments
Oral language modifiers	Yes	All assessments
Modified question papers	Yes	All assessments
Extra time	Yes	All assessments

7.2 Arrangements for candidates with particular requirements (including Special Consideration)

All candidates with a demonstrable need may be eligible for access arrangements to enable them to show what they know and can do. The criteria for eligibility for access arrangements can be found in the JCQ document *Access Arrangements, Reasonable Adjustments and Special Consideration.*

Candidates who have been fully prepared for the assessment but who have been affected by adverse circumstances beyond their control at the time of the examination may be eligible for special consideration. As above, centres should consult the JCQ document *Access Arrangements, Reasonable Adjustments and Special Consideration.*

8 Administration of GCSE Science B

In December 2011 the GCSE qualification criteria were changed by Ofqual. As a result, all GCSE qualifications have been updated to comply with the new regulations.

The most significant change for all GCSE qualifications is that, from 2014, unitised specifications must require that 100% of the assessment is terminal.

Please note that there are no changes to the terminal rule and re-sit rules for the January 2013 and June 2013 examination series:

- at least 40% of the assessment must be taken in the examination series in which the qualification is certificated
- candidates may re-sit each unit once before certification, i.e. each candidate can have two attempts at a unit before certification.

For full information on the assessment availability and rules that apply in the January 2013 and June 2013 examination series, please refer to the previous version of this specification GCSE Science B (March 2011) available on the website (include direct link to current spec).

The sections below explain in more detail the rules that apply from the June 2014 examination series onwards.

8.1 Availability of assessment from 2014

There is one examination series available each year in June (all units are available each year in June).

GCSE Science B certification is available in June 2014 and each June thereafter.

	Unit B711	Unit B712	Unit B713	Certification availability
June 2014	✓	✓	✓	✓
June 2015	✓	✓	✓	✓

8.2 Certification rules

For GCSE Science B, from June 2014 onwards, a 100% terminal rule applies. Candidates must enter for all their units in the series in which the qualification is certificated.

8.3 Rules for re-taking a qualification

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

Where a candidate re-takes a qualification, **all** units must be re-entered and all externally assessed units must be re-taken in the same series as the qualification is re-certificated. The new results for these units will be used to calculate the new qualification grade. Any results previously achieved cannot be re-used.

For the controlled assessment unit, candidates who are re-taking a qualification can choose either to re-take that controlled assessment unit or to carry forward the result for that unit that was used towards the previous certification of the same qualification.

- Where a candidate decides to re-take the controlled assessment, the new result will be the one used to calculate the new qualification grade. Any results previously achieved cannot be re-used.
- Where a candidate decides to carry forward a result for controlled assessment, they must be entered for the controlled assessment unit in the re-take series using the entry code for the carry forward option (see section 8.4).

8.4 Making entries

8.4.1 Unit entries

Centres must be approved to offer OCR qualifications before they can make any entries, including estimated entries. It is recommended that centres apply to OCR to become an approved centre well in advance of making their first entries. Centres must have made an entry for a unit in order for OCR to supply the appropriate forms and administrative materials.

It is essential that correct unit entry codes are used when making unit entries.

For the externally assessed units B711 and B712 candidates must be entered for either component 01 (Foundation Tier) or 02 (Higher Tier) using the appropriate unit entry code from the table below. It is not possible for a candidate to take both components for a particular unit within the same series; however, different units may be taken at different tiers.

For the controlled assessment unit, centres can decide whether they want to submit candidates' work for moderation through the OCR Repository or by post. Candidates submitting controlled assessment must be entered for the appropriate unit entry code from the table below. Candidates who are re-taking the qualification and who want to carry forward the controlled assessment should be entered using the unit entry code for the carry forward option.

Centres should note that controlled assessment tasks can still be completed at a time which is appropriate to the centre/candidate. However, where tasks change from year to year, centres would have to ensure that candidates had completed the correct task(s) for the year of entry.

Unit entry code	Component code	Assessment method	Unit titles
B711F	01	Written Paper	*Science modules B1, C1, P1* (Foundation Tier)
B711H	02	Written Paper	*Science modules B1, C1, P1* (Higher Tier)
B712F	01	Written Paper	*Science modules B2, C2, P2* (Foundation Tier)
B712H	02	Written Paper	*Science modules B2, C2, P2* (Higher Tier)
B713A	01	Moderated via OCR Repository	*Science controlled assessment*
B713B	02	Moderated via postal moderation	*Science controlled assessment*
B713C	80	Carried forward	*Science controlled assessment*

8.4.2 Certification entries

Candidates must be entered for qualification certification separately from unit assessment(s). If a certification entry is **not** made, no overall grade can be awarded.

Centres must enter candidates for:

- GCSE Science B certification code J261

8.5 Enquiries about results

Under certain circumstances, a centre may wish to query the result issued to one or more candidates. Enquiries about results for GCSE units must be made immediately following the series in which the relevant unit was taken and by the relevant enquiries about results deadline for that series.

Please refer to the JCQ *Post-Results Services* booklet and the OCR *Admin Guide: 14–19 Qualifications* for further guidance on enquiries about results and deadlines. Copies of the latest versions of these documents can be obtained from the OCR website at www.ocr.org.uk.

8.6 Prohibited qualifications and classification code

Every specification is assigned a national classification code indicating the subject area to which it belongs. The classification code for this specification is QA1B.

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.

Centres may wish to advise candidates that, if they take two specifications with the same classification code, colleges are very likely to take the view that they have achieved only one of the two GCSEs. The same view may be taken if candidates take two GCSE specifications that have different classification codes but have significant overlap of content. Candidates who have any doubts about their subject combinations should seek advice, either from their centre or from the institution to which they wish to progress.

9 Other information about GCSE Science B

9.1 Overlap with other qualifications

This specification has been developed alongside GCSE Additional Science B, GCSE Biology B, GCSE Chemistry B, GCSE Physics B and GCSE Additional Applied Science.

This specification includes the content of Modules 1 and 2 of GCSE Biology B, GCSE Chemistry B and GCSE Physics B.

9.2 Progression from this qualification

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

Progression to further study from GCSE will depend upon the number and nature of the grades achieved. Broadly, candidates who are awarded mainly Grades D to G at GCSE could either strengthen their base through further study of qualifications at Level 1 within the National Qualifications Framework or could proceed to Level 2. Candidates who are awarded mainly Grades A* to C at GCSE would be well prepared for study at Level 3 within the National Qualifications Framework.

9.3 Avoidance of bias

OCR has taken great care in preparation of this specification and assessment materials to avoid bias of any kind. Special focus is given to the 9 strands of the Equality Act with the aim of ensuring both direct and indirect discrimination is avoided.

9.4 Regulatory Requirements

This specification complies in all respects with the current: *General Conditions of Recognition; GCSE, GCE, Principal Learning and Project Code of Practice; GCSE Controlled Assessment regulations* and the *GCSE subject criteria for Science.* All documents are available on the Ofqual website.

9.5 Language

This specification and associated assessment materials are in English only. Only answers written in English will be assessed.

9.6 Spiritual, moral, ethical, social, legislative, economic and cultural issues

This specification offers opportunities which can contribute to an understanding of these issues. The table below gives some examples which could be used when teaching the course:

Issue	Opportunities for developing an understanding of the issue during the course
Moral issues The commitment of scientists to publish their findings and subject their ideas to testing by others.	B1c: Discuss the benefits and risks (possible side effects) associated with immunisation. B2f: Explain how Lamarck's idea of evolution by the inheritance of acquired characteristics was different from Darwin's theory. C1a: Discuss the problems associated with the finite nature of crude oil.
Ethical issues The ethical implications of selected scientific issues.	B1h: Discuss the issues raised by knowledge of inherited disorders in a family. C1a: Describe some of the environmental problems involved in the exploitation of crude oil. C1g: Recall that testing of cosmetics on animals is banned in the UK. P2d: Explain the problems of dealing with radioactive waste.
Economical issues The range of factors which have to be considered when weighing the costs and benefits of scientific activity.	C1e: Explain some of the environmental and economic issues related to the use of polymers. C2e: Explain that economic considerations determine the conditions used in the manufacture of chemicals.
Cultural issues Scientific explanations which give insight into the local and global environment.	B2h: Recognise that sustainability requires planning and co-operation at local, national and international levels. C1c: Research the increase in occurrences of asthma in the UK and possible links with air pollution. P1h: Describe reasons for climate change caused by increased global warming.

9.7 Sustainable development, health and safety considerations and European developments, consistent with international agreements

This specification supports these issues, consistent with current EU agreements, as outlined below.

- Sustainable development issues could be supported through questions set on maintaining biodiversity, choice of fuels and the effects of human activity on climate, for example.
- Health and safety considerations will be supported through the controlled assessment which will include safely planning and carrying out practical work. Health and safety considerations could be supported through questions set on maintaining health of both individuals and societies, safe use of radiations, for example.
- European developments could be supported through study of the effects of increasing human populations, for example.

9.8 Key Skills

This specification provides opportunities for the development of the Key Skills of *Communication, Application of Number, Information and Communication Technology, Working with Others, Improving 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 each unit.

Unit	C		AoN		ICT		WwO		IOLP		PS	
	1	2	1	2	1	2	1	2	1	2	1	2
B711	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
B712	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
B713	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

9.9 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:

- using videos clips to show/provide the context for topics studied and to illustrate the practical importance of the scientific ideas
- gathering information from the internet 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 modelling software to explore theories
- using software to present ideas and information on paper and on screen.

Particular opportunities for the use of ICT appear in the introductions to each Item where appropriate.

9.10 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.

A Appendix A: Guidance for the production of electronic controlled assessment

Structure for evidence

A controlled assessment portfolio is a collection of folders and files containing the candidate's evidence. Folders should be organised in a structured way so that the evidence can be accessed easily by a teacher or moderator. This structure is commonly known as a folder tree. It would be helpful if the location of particular evidence is made clear by naming each file and folder appropriately and by use of an index called 'Home Page'.

There should be a top level folder detailing the candidate's centre number, candidate number, surname and forename, together with the unit code B713, so that the portfolio is clearly identified as the work of one candidate.

Each candidate produces an assignment for controlled assessment. The evidence should be contained within a separate folder within the portfolio. This folder may contain separate files.

Each candidate's controlled assessment portfolio should be stored in a secure area on the centre's network. Prior to submitting the controlled assessment portfolio to OCR, the centre should add a folder to the folder tree containing controlled assessment and summary forms.

Data formats for evidence

In order to minimise software and hardware compatibility issues it will be necessary to save candidates' work using an appropriate file format.

Candidates must use formats appropriate to the evidence that they are providing and appropriate to viewing for assessment and moderation. Open file formats or proprietary formats for which a downloadable reader or player is available are acceptable. Where this is not available, the file format is not acceptable.

Electronic controlled assessment is designed to give candidates an opportunity to demonstrate what they know, understand and can do using current technology. Candidates do not gain marks for using more sophisticated formats or for using a range of formats. A candidate who chooses to use only word documents will not be disadvantaged by that choice.

Evidence submitted is likely to be in the form of word processed documents, PowerPoint presentations, digital photos and digital video.

To ensure compatibility, all files submitted must be in the formats listed below. Where new formats become available that might be acceptable, OCR will provide further guidance. OCR advises against changing the file format that the document was originally created in. It is the centre's responsibility to ensure that the electronic portfolios submitted for moderation are accessible to the moderator and fully represent the evidence available for each candidate.

Accepted file formats

A

Movie formats for digital video evidence
MPEG (*.mpg)
QuickTime movie (*.mov)
Macromedia Shockwave (*.aam)
Macromedia Shockwave (*.dcr)
Flash (*.swf)
Windows Media File (*.wmf)
MPEG Video Layer 4 (*.mp4)

Audio or sound formats
MPEG Audio Layer 3 (*.mp3)

Graphics formats including photographic evidence
JPEG (*.jpg)
Graphics file (*.pcx)
MS bitmap (*.bmp)
GIF images (*.gif)

Animation formats
Macromedia Flash (*.fla)

Structured markup formats
XML (*.xml)

Text formats
Comma Separated Values (.csv)
PDF (.pdf)
Rich text format (.rtf)
Text document (.txt)

Microsoft Office suite
PowerPoint (.ppt)
Word (.doc)
Excel (.xls)
Visio (.vsd)
Project (.mpp)

B Appendix B: Mathematics skills for GCSE science qualifications

Candidates are permitted to use calculators in all assessments.

Candidates should be able to:

- understand number size and scale and the quantitative relationship between units
- understand when and how to use estimation
- carry out calculations involving +, – , ×, ÷, either singly or in combination, decimals, fractions, percentages and positive whole number powers
- provide answers to calculations to an appropriate number of significant figures
- understand and use the symbols =, <, >, ~
- understand and use direct proportion and simple ratios
- calculate arithmetic means
- understand and use common measures and simple compound measures such as speed
- plot and draw graphs (line graphs, bar charts, pie charts, scatter graphs, histograms) selecting appropriate scales for the axes
- substitute numerical values into simple formulae and equations using appropriate units
- translate information between graphical and numeric form
- extract and interpret information from charts, graphs and tables
- understand the idea of probability
- calculate area, perimeters and volumes of simple shapes.

In addition, Higher Tier candidates should be able to:

- interpret, order and calculate with numbers written in standard form
- carry out calculations involving negative powers (only -1 for rate)
- change the subject of an equation
- understand and use inverse proportion
- understand and use percentiles and deciles.

Appendix C: Physical quantities and units

C

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 (°C); 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°C; J/g°C
specific latent heat	J/kg

D Appendix D: Health and safety

In UK law, health and safety is the responsibility of the employer. For most establishments entering candidates for GCSE, this is likely to be the local education authority or the governing body. Employees, i.e. teachers and lecturers, have a duty to cooperate with their employer on health and safety matters. Various regulations, but especially the COSHH Regulations 2002 and the Management of Health and Safety at Work Regulations 1999, require that before any activity involving a hazardous procedure or harmful micro-organisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment.

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, 11th edition, 2006, ASE ISBN 978 0 86357 408 5

CLEAPSS® *Hazcards*, 2007 edition and later updates*

CLEAPSS® *Laboratory Handbook**

Hazardous Chemicals, A Manual for Science Education, 1997, SSERC Limited, ISBN 0 9531776 0 2

Where an employer has adopted these or other publications as the basis of their model risk assessments, an individual school or college 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.

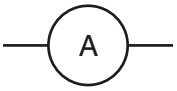
Where project work or individual investigations, sometimes linked to work-related activities, are included in specifications this may well lead to the use of novel procedures, chemicals or micro-organisms, which are not covered by the employer's model risk assessments. The employer should have given guidance on how to proceed in such cases. Often, for members, it will involve contacting CLEAPSS® (or, in Scotland, SSERC).

*These, and other CLEAPSS® publications, are on the CLEAPSS® Science Publications CD-ROM issued annually to members. Note that CLEAPSS® publications are only available to members. For more information about CLEAPSS® www.cleapss.org.uk. In Scotland, SSERC www.sserc.org.uk has a similar role to CLEAPSS® and there are some reciprocal arrangements.

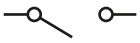
Appendix E: Electrical symbols

Junction of Conductors

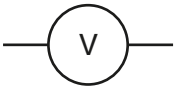
Ammeter



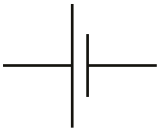
Switch



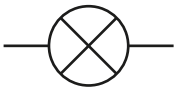
Voltmeter



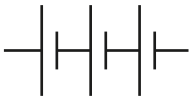
Primary or secondary cell



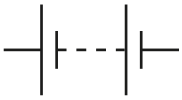
Indicator or light source



Battery of cells

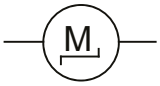


or

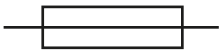


Power supply

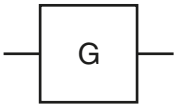
Motor



Fuse

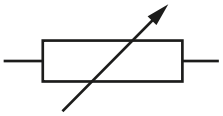


Generator

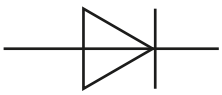


Fixed resistor

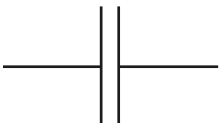
Variable resistor



Diode

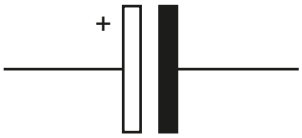


Capacitor

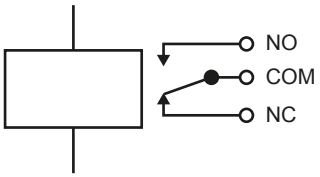


E

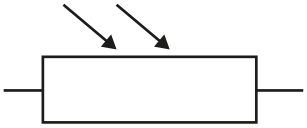
Electrolytic capacitor



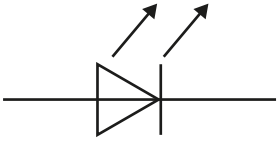
Relay



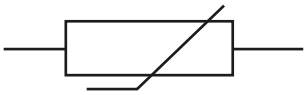
LDR



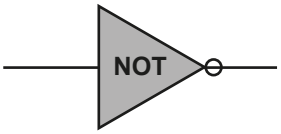
LED



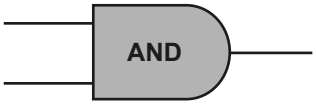
Thermistor



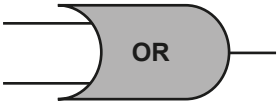
NOTgate



AND gate

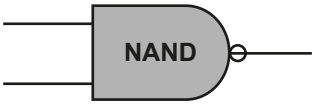


OR gate

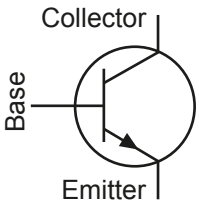


NOR gate

NAND gate



NPN transistor



Appendix F: Periodic Table

F

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						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** 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.

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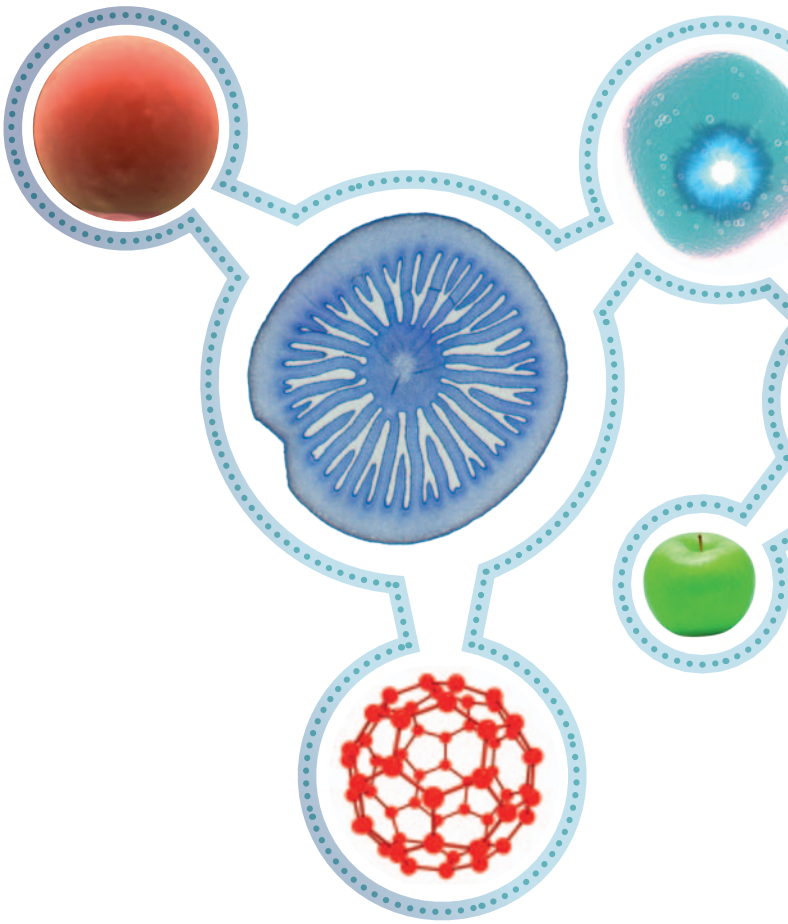
Coventry CV4 8JQ



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