Rewarding Learning

NOTE
CCEA will NOT be accepting entries from English centres for GCSE courses that begin in or after September 2012

CCEA GCSE Specification in Science (Double Award - Unitised)

For first teaching from September 2011

For first assessment from November 2011
For first award in Summer 2013

Subject Code: 1370

science
double award - unitised

Version 4 7 June 2013

Foreword

This booklet contains CCEA's General Certificate of Secondary Education (GCSE) Double Award Science for first teaching from September 2011. We have designed this specification to meet the requirements of the following:

- GCSE Subject Criteria for Science and Additional Science;
- GCSE Qualifications Criteria;
- Common Criteria for all Qualifications;
- GCSE Controlled Assessment Additional Science Regulations; and
- GCSE Controlled Assessment Generic Regulations.

We will make the first full award based on this specification in summer 2013.

We are now offering this specification as a unitised course. This development increases flexibility and choice for teachers and learners.

The first assessment for the following units will be available in November 2011:

- Biology Unit 1 (Foundation/Higher): Living Processes and Biodiversity;
- Chemistry Unit 1 (Foundation/Higher): Structures, Trends and Chemical Reactions; and
- Physics Unit 1 (Foundation/Higher): Force and Motion, Energy, Moments and Radioactivity.

We will notify centres in writing of any major changes to this specification. We will also publish changes on our website at www.ccea.org.uk

The version on our website is the most up-to-date version. Please note that the web version may be different from printed versions.

Subject Code	1370
QAN	600/1165/8

You may download further copies of this publication from www.ccea.org.uk

Version 4: 7 June 2013

Contents

1 Introduction

This specification sets out the content and assessment details for our GCSE Double Award Science course. First teaching begins from September 2011, and we will make the first awards for this specification in 2013. You can view and download the latest version of this specification on our website at www.ccea.org.uk

The specification builds on the broad objectives of the Northern Ireland Curriculum. It is also relevant to key curriculum concerns in Wales and is designed to promote continuity, coherence and progression within the study of Double Award Science.

A course based on this specification should help facilitate the study of science, physics, chemistry, biology and related subjects at a more advanced level, for example Advanced Subsidiary and Advanced Physics, Chemistry, and Biology. For those progressing directly into employment, a GCSE in Double Award Science is relevant not only to the fields of science and engineering, but also to areas of commerce and public service that value problem-solving and practical skills.

1.1 Aims and learning outcomes

This specification encourages students to be inspired, motivated and challenged by following a broad, coherent, practical, satisfying and worthwhile course of study. It encourages them to develop their curiosity about the living, material and physical worlds and provides insight into and experience of how science works. It enables students to engage with science and to make informed decisions both about further study in science and related subjects and about their careers.

This specification aims to enable students to:

- develop their knowledge and understanding of the material, physical and living worlds;
- develop their understanding of the effects of science on society;
- develop an understanding of the importance of scale in science;
- develop and apply their knowledge and understanding of the nature of science and of the scientific process;
- 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, modelling, 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 both qualitatively and quantitatively; and
- develop their skills in communication, mathematics and the use of technology in scientific contexts.

1.2 Key features

The key features of the specification appear below:

- The specification involves a new approach to Double Award Science at GCSE by incorporating the skills, knowledge and understanding of how science works.
- The Specification is a unitised specification that includes seven units.
- Units 1–3 are available for assessment in the first year of teaching.
- Units 1–6 are each assessed through a written examination, either at Foundation Tier (grades C–G) or Higher Tier (grades A*–D / E).
- From 2013, students will be able to receive two different grades in their Double Award Science qualification, such as AB or BC.
- We set the controlled assessment tasks for the Practical Skills unit. Students must complete two tasks. Teachers supervise them and mark students according to our mark scheme, and we moderate the results.
- Students can resit each unit once.
- The specification allows students to develop transferable skills that will benefit them in vocational training and employment. It is also possible to progress to the study of science and related courses at GCE Advanced Level and Advanced Subsidiary Level.
- There is a range of support available for both teachers and students, including specimen papers, mark schemes and schemes of work. You can download these from our website at www.ccea.org.uk

1.3 Prior attainment

The specification builds on the knowledge, skills and understanding developed through the Northern Ireland curriculum for science at Key Stage 3. There is no particular level of attainment required; however, before studying this specification, we expect students to have a level of skills in science, numeracy, literacy and communication that is commensurate with having studied science to Key Stage 3.

1.4 Classification codes and subject combinations

Every specification is assigned a national classification code that indicates the subject area to which it belongs. The classification code for this qualification is 1370.

Progression to another school/college

Should a student take two qualifications with the same classification code, schools and colleges that they apply to may take the view that they have achieved only one of the two GCSEs. The same view may be taken if students take two GCSE qualifications that have different classification codes but have content that overlaps significantly. Students who have any doubts about their subject combinations should check with the schools and colleges that they wish to attend before embarking on their planned study.

1.5 How science works

Section 3 of our specification includes learning outcomes that allow students to develop the specific skills, knowledge and understanding of how science works. To identify these clearly, the learning outcome is followed by the letter *w* and is cross referenced to the specific skills, knowledge and understanding that appear below (for example (*w – (ii)b*)).

The skills, knowledge and understanding of how science works are:

(i) data evidence, theories and explanations:

- (a) the collection and analysis of scientific data;
- (b) the interpretation of data, using creative thought, to provide evidence for testing ideas and developing theories;
- (c) many phenomena can be explained by developing and using scientific theories, models and ideas; and
- (d) there are some questions that science cannot currently answer and some that science cannot address;

(ii) practical and enquiry skills:

- (a) planning to test a scientific idea, answer a scientific question or solve a scientific problem;
- (b) collecting data from primary or secondary sources, including the use of ICT sources and tools;
- (c) working accurately and safely, individually and with others, when collecting first-hand data; and
- (d) evaluating methods of data collection and considering their validity and reliability as evidence;

(iii) communication skills:

- (a) recalling, analysing, interpreting, applying and questioning scientific information or ideas;
- (b) using both qualitative and quantitative approaches; and
- (c) presenting information, developing an argument and drawing a conclusion, using scientific, technical and mathematical language, conventions and symbols, and using ICT tools;

(iv) applications and implications of science:

- (a) the use of contemporary scientific and technological developments and their benefits, drawbacks and risks;
- (b) how and why decisions about science and technology are made, including those that raise ethical issues, and about the social, economic and environmental effects of such decisions; and
- (c) how uncertainties in scientific knowledge and scientific ideas change over time and the role of the scientific community in validating these changes.

2 Specification at a Glance

The table below summarises the structure of this GCSE course:

Content	Assessment	Weighting	Availability
Biology Unit 1: Living Processes and Biodiversity	An externally assessed written examination consisting of a number of compulsory structured questions that provide opportunities for short answers, extended writing and calculations Foundation and Higher Tiers: 1 hour	11%	Every November, February and Summer (beginning in November 2011)
Chemistry Unit 1: Structures, Trends and Chemical Reactions	An externally assessed written examination consisting of a number of compulsory structured questions that provide opportunities for short answers, extended writing and calculations Foundation and Higher Tiers: 1 hour	11%	Every November, February and Summer (beginning in November 2011)
Physics Unit 1: Force and Motion, Energy, Moments, and Radioactivity	An externally assessed written examination consisting of a number of compulsory structured questions that provide opportunities for short answers, extended writing and calculations Foundation and Higher Tiers: 1 hour	11%	Every November, February and Summer (beginning in November 2011)
Biology Unit 2: Body Systems, Genetics, Microorganisms and Health	An externally assessed written examination consisting of a number of compulsory structured questions that provide opportunities for short answers, extended writing and calculations Foundation and Higher Tiers: 1 hour 15 mins	14%	Summer only (beginning in 2013)
Chemistry Unit 2: Further Chemical Reactions and Organic Chemistry	An externally assessed written examination consisting of a number of compulsory structured questions that provide opportunities for short answers,	14%	Summer only (beginning in 2013)

Content	Assessment	Weighting	Availability
	extended writing and calculations Foundation and Higher Tiers: 1 hour 15 mins		
Physics Unit 2: Waves, Sound and Light, Electricity, and the Earth and Universe	An externally assessed written examination consisting of a number of compulsory structured questions that provide opportunities for short answers, extended writing and calculations Foundation and Higher Tiers: 1 hour 15 mins	14%	Summer only (beginning in 2013)
Practical Skills Unit	Controlled assessment Students complete two controlled assessment tasks from a choice of six. The two tasks must come from different subject areas within the specification. (See Section 3 for details.) Teachers mark the task and we moderate the results.	25%	From September (beginning in 2011) (submitted every May beginning 2013)

At least 40 percent of the assessment (based on unit weightings) must be taken at the end of the course as terminal assessment.

3 Subject Content

We have divided the course into seven units. The content of each unit, as well as the respective learning outcomes, appears below.

Content for the Higher Tier only is in ***bold italics***.
Questions in Higher Tier papers may be set on any content in the specification.

Content for the Foundation Tier is in normal type.
Questions in Foundation Tier papers will be set only on this content.

Students should have opportunities to experiment and carry out their own investigations throughout their course of study.

Biology Unit 1 (B1): Living Processes and Biodiversity

Investigating Ecology, Classification and Biodiversity Populations

Students observe living specimens and carry out fieldwork in a natural ecosystem. Any animals or plants they collect should be returned to their habitat as soon as possible. Students also investigate that life on Earth is widely diverse and is more easily understood when classified into well defined groups. They explore how organisms are adapted to their environment and to compete for resources, and the factors affecting changes in population.

Content	Learning Outcomes
B1.1 Investigating Ecology, Classification and Biodiversity Populations	In the context of how science works, students should be able to: 1.1.1 use appropriate sampling techniques, for example quadrats, pooters, pitfall traps and nets, to investigate changes in the distribution of organisms within a sample area of a habitat (*w – all of (ii)*);
Fieldwork and Classification	1.1.2 use observations from organisms identified in fieldwork to help describe the main features of: - flowering plants – true roots, stems and leaves with specialised vascular tissue, flower and seed production with a fruit; - annelids – segmentation, chaetae, and body temperature not constant; - insects – exoskeleton, three regions to body (head, thorax and abdomen), three pairs of jointed legs, two pairs of wings, and body temperature not constant; and - chordates – only as animals with backbones; and
Ecological Terms	1.1.3 understand the meaning of the terms biodiversity, population, habitat, environment, community and ecosystem.

Content	Learning Outcomes
Ecological Measurements	In the context of how science works, students should be able to: 1.1.4 measure biotic and abiotic factors such as wind speed, water, pH, light, temperature and biodiversity (the number of plant and animal species) (*w – (ii)b, (ii)c, (ii)d*);
Distribution of Organisms	1.1.5 use data collected (primary or secondary) as evidence to account for the distribution of organisms (*w – (i)a, (ii) b, (ii)d, (iii)c*);
Competition	1.1.6 account for this distribution in terms of the adaptations of the organisms found to their environment and competition for resources, which can affect population growth (water, light, space and minerals in plants, and water, food, territory and mates in animals) (*w – (i)c*);
Evaluation of Data Collection	1.1.7 evaluate the validity and reliability of data collected during fieldwork when drawing conclusions about the methods of data collection and the environment (*w – (ii)d*);
Keys	1.1.8 use keys to identify organisms and classify them into major groups based on observable features (*w – (iii)a, (iii)b*); and
Population Changes	1.1.9 use mathematical models to explain changes in populations and explain the consequences of changes in population density for the environment, to include birth and death rates, emigration and immigration (*w – (i)c*).

Ecological Relationships and Energy Flow

Students develop an understanding that life on Earth is ultimately reliant on energy from the Sun and that this energy is transferred through the ecosystem by feeding relationships.

Content	Learning Outcomes
B1.2 Ecological Relationships and Energy Flow	In the context of how science works, students should be able to: 1.2.1 understand that the Sun is the source of energy for most ecosystems on Earth and understand the role of green plants as producers in capturing this energy and making it available to other organisms; and
Food Chains and Food Webs	1.2.2 understand food chains and webs and identify producers, consumers and trophic levels.

Content	Learning Outcomes
Pyramids of Numbers and Biomass	In the context of how science works, students should be able to: 1.2.3 construct pyramids of numbers and biomass as models of food chains and explain the difference (*w – (iii)b, (iii)c*);
Energy Flow	1.2.4 use data to interpret and explain decreases in the amount of energy available at each trophic level due to heat from respiration, movement, waste materials, and uneaten structures, *and understand why shorter food chains are more efficient* (*w – all of (iii)*);
Carbon Cycle	1.2.5 understand the significance of photosynthesis, respiration, combustion, fossilisation, feeding, excretion, egestion and decomposition within the carbon cycle, and the constant removing and returning of substances from the environment (*w – (iii)a*);
Minerals	1.2.6 understand that plants need nitrates to form proteins and that they obtain these from the soil through root hair cells *by active uptake;* 1.2.7 identify root hair cells as specialised cells that are adapted by having an extended shape, providing an increased surface area for increased uptake of water and minerals; 1.2.8 *understand that active uptake is a process that requires energy to transport the minerals against a concentration gradient* (*w – all of (iii)*); 1.2.9 understand why growers add minerals to the soil, to include calcium, magnesium and nitrogen, and compare the use of natural fertilisers (farmyard manure and compost) and artificial fertilisers as a means of replacing nitrates in soil (*w – all of (iii)*); and
Nitrogen Cycle	1.2.10 *understand the role that microorganisms have in the nitrogen cycle, to include nitrogen fixation, nitrification, de-nitrification and decomposition (knowledge of the names of specific bacteria is not required) and apply this to different growing conditions* (*w – (iii)a*).

Human Activity and Its Effects on the Environment

Students investigate how humans can alter their environment in order to increase its capacity to support human life, evaluate the effect of these changes, and appreciate that these may have immediate local benefits but can have adverse consequences which may be global and long lasting.

<table>
<tr><th>Content</th><th>Learning Outcomes</th></tr>
<tr><td>B1.3
Human Activity and Its Effects on the Environment

Monitoring Environmental Changes</td><td>In the context of how science works, students should be able to:

1.3.1 carry out studies or analyse data to monitor environmental changes (w – (ii)b), to include:
- biotic data, for example lichens as indicator species of air pollution and blood worms as indicator species of water pollution caused by eutrophication; and
- abiotic data, for example carbon dioxide levels;

1.3.2 understand the need for monitoring of environmental change (for example monitoring levels of carbon dioxide in the air);</td></tr>
<tr><td>Global Warming</td><td>1.3.3 understand that collaborative scientific research suggests that an increase in levels of carbon dioxide leads to global warming and understand the problems associated with this, and realise that there is controversy associated with the recording, sources, modelling and possible solutions to this problem;</td></tr>
<tr><td>Eutrophication</td><td>1.3.4 explain how sewage disposal and fertiliser run-off can cause eutrophication in terms of:
- nitrates stimulating growth of aquatic plants and algae;
- the death of aquatic plants and algae due to shading;
- the role of aerobic microorganisms in the decomposition of plants and algae; and
- the consequences of oxygen depletion on other aquatic vertebrates and invertebrates (w – (iv)b); and</td></tr>
<tr><td>International Treaties</td><td>1.3.5 outline the role of international treaties in combating pollution (w – (iv)b).</td></tr>
</table>

Photosynthesis and Plants

Students investigate and explain photosynthesis as the key process that enables plants to make food, as well as the role of plants in supporting life.

Content	Learning Outcomes
B1.4 Photosynthesis and Plants Investigating Photosynthesis	In the context of how science works, students should be able to: 1.4.1 investigate how light, carbon dioxide and chlorophyll are needed for photosynthesis (*w – all of (ii)*): - how and why a plant is destarched; - the steps involved in testing a leaf for starch (*w – (iii)b*); - the production of oxygen (*w – (iii)b*); - using a variegated leaf to illustrate the role of chlorophyll in the chloroplast in trapping light; and - deriving the word equation for photosynthesis (*w – (i)b*);
Uses of Products of Photosynthesis	1.4.2 explain how a plant uses the products of photosynthesis;
Limiting Factors	1.4.3 investigate the factors affecting the rate of photosynthesis (light intensity, temperature and concentration of carbon dioxide) and interpret data on the rate of photosynthesis in terms of limiting factors (*w – all of (ii)*);
Economic Implications	1.4.4 using secondary sources of data, investigate the economic implications in commercial crop production of enhancing environmental factors (artificial lighting, carbon dioxide enrichment and fertilisers) (*w – (ii)b, (ii)d*); and
Hydrogen-carbonate Indicator	1.4.5 *investigate (using hydrogencarbonate indicator) the relationship between photosynthesis and respiration in plants, to include knowledge of the colour changes of hydrogencarbonate indicator (high CO_2 – yellow, normal CO_2 – red, low CO_2 – purple)* (*w – all of (ii), (iii)a*).

Nutrition and Health

Students investigate food composition and health issues associated with our approach to food and exercise.

<table>
<tr><th>Content</th><th>Learning Outcomes</th></tr>
<tr>
<td>B1.5
Nutrition and Health

Food Tests</td>
<td>In the context of how science works, students should be able to:

1.5.1 by carrying out food tests, investigate the idea of a balanced diet by using food samples and food test reagents, including:
- reducing sugar (Benedict’s);
- starch (iodine solution);
- amino acid/protein (Biuret);
- fats (ethanol); and
- Vitamin C (DCPIP) (w – (ii)a, (ii)b, (ii)c, (iii)b);

1.5.2 recall the following reagents and their colour changes:
<table>
<tr><th>Reagent</th><th>Initial colour</th><th>End colour for positive result</th></tr>
<tr><td>Benedict’s</td><td>Blue</td><td>Brick red precipitate</td></tr>
<tr><td>Iodine</td><td>Yellow/Brown</td><td>Blue/Black</td></tr>
<tr><td>Biuret</td><td>Blue</td><td>Purple</td></tr>
<tr><td>Ethanol</td><td>Clear</td><td>White emulsion</td></tr>
<tr><td>DCPIP</td><td>Blue</td><td>Pink and then colourless</td></tr>
</table>
1.5.3 use DCPIP to compare quantitatively (volume × concentration) the vitamin C content of vegetable and fruit juices to a standard solution of ascorbic acid – juices for comparison can be natural, processed or boiled (w – all of (ii), (iii)b, (iii)c);</td>
</tr>
<tr>
<td>Food and Health</td>
<td>1.5.4 understand how human health is affected by:
- inherited factors;
- environmental factors – obesity can be caused by energy intake being higher than energy used in exercise; and
- healthy food choices – limited intake of sugar, salt and fat and the benefit of fruit and vegetables; and

1.5.5 understand the contribution of an unhealthy diet to obesity, heart disease, strokes, high blood pressure and diabetes (w – (iii)a).</td>
</tr>
</table>

Enzymes and Digestion

Students investigate enzymes and their role in digestion. They also learn about how digested food enters the bloodstream.

Content	Learning Outcomes
B1.6 Enzymes and Digestion Enzymes	In the context of how science works, students should be able to: 1.6.1 investigate the actions of enzymes as proteins that are biological catalysts which speed up the rate of reactions, to include amylase, and interpret the results in terms of the lock and key model illustrating substrate specificity (*w – (i)c, all of (ii)*); 1.6.2 investigate and interpret the effects of temperature, pH and enzyme concentration on the action of enzymes (*w – all of (ii)*);
Digestion and Absorption	1.6.3 understand that enzymes are needed to break down (digest) large, insoluble molecules into small, soluble ones: - in biological washing powders, as an example of commercial use; and - in the digestion of food, which can then be absorbed into the bloodstream, in the body, for example proteases in acid conditions in the stomach and proteases, lipases and amylases in the small intestine; 1.6.4 understand that the small intestine is adapted for digestion and absorption by having a large surface area (length, folds and villi) for digestion and absorption, and a good blood supply for absorption; and 1.6.5 *explain how the structure of a villus (finger-like shape, single layer of surface cells, capillary network and lacteal) is adapted for the efficient absorption of digested food molecules.*

Respiration

Students explore how respiratory surfaces in plants and animals are adapted to ensure rapid gas exchange. They also learn about aerobic respiration and its similarities to and differences from anaerobic respiration.

Content	Learning Outcomes
B1.7 Respiration	In the context of how science works, students should be able to:
Respiratory Surfaces	1.7.1 explain the adaptations of respiratory surfaces in plants and animals, to include large surface area, thin, moist, permeable, good blood supply and diffusion gradient (*w – (iii)a*);
Aerobic Respiration	1.7.2 recall the word equation for aerobic respiration; glucose + oxygen → carbon dioxide + water + energy
	1.7.3 investigate the energy released from food in respiration by burning food samples, calculate the results and compare their data with data from food labels, evaluating the methods of data collection and their reliability and validity (*w – all of (ii), (iii)a*); and
Aerobic and Anaerobic Respiration	1.7.4 *compare and contrast aerobic and anaerobic respiration in mammalian muscle and yeast, to include the word equations for mammalian muscles and yeast.*

Nervous System and Hormones

Students understand how the nervous system and hormones are involved in coordination and internal maintenance in the body. The role of hormones in plants is also explored.

Content	Learning Outcomes
B1.8 Nervous System and Hormones	In the context of how science works, students should be able to: 1.8.1 compare and contrast the two communication systems in the human body (nervous system and hormonal system), to include the speed and nature of the response (*w – (iii)a*);
Central Nervous System	1.8.2 know that the brain and spinal cord form the central nervous system that controls and coordinates the responses between the receptors and effectors (muscles);
Hormones	1.8.3 understand that hormones, to include insulin, are chemical messengers that travel in the blood to a target organ, where they act (*w – (iii)a*): - insulin is produced by the pancreas in response to increasing blood glucose levels and acts in the liver; and - insulin lowers blood glucose levels by converting glucose to glycogen or respiring more glucose in the liver;
Diabetes	1.8.4 understand that: - diabetes is a condition in which the blood glucose control mechanism fails; - the symptoms of diabetes include high blood glucose, the presence of glucose in the urine, lethargy and thirst; and - possible long-term effects of diabetes include eye damage, kidney failure, heart disease and strokes (*w – (i)b, (i)c, (i)d*); and
Plant Hormones	1.8.5 investigate and interpret evidence (secondary data) on how plants respond to external stimuli – phototropism in stems as a differential growth of cells caused by uneven distribution of the hormone auxin in response to light (*w – all of (ii)*).

3.2 Biology Unit 2 (B2): Body Systems, Genetics, Microorganisms and Health

Osmosis and Plant Transport

Students investigate the transport of water between the cells and organs of a plant.

Content	Learning Outcomes
B2.1 Osmosis and Plant Transport Osmosis, Plasmolysis and Turgidity	In the context of how science works, students should be able to: 2.1.1 carry out investigations, collect data and draw conclusions to demonstrate the process of osmosis (across selectively permeable membranes) in plant tissue, to include: - the change in size and mass of plant tissue (*w – (ii)b, (ii)c, (ii)d*); and - the use of a microscope to identify changes in plant cell structure that occur in plasmolysed and turgid cells due to osmosis (*w – (ii)b*); 2.1.2 explain osmosis as diffusion of water from a dilute solution to a more concentrated solution, through a selectively permeable membrane; 2.1.3 explain how osmosis causes plant cells to become plasmolysed and turgid; 2.1.4 understand the role of the cell wall in limiting the entry of water;
Uses of Water	2.1.5 understand that plants use water for support, transport, transpiration and photosynthesis;
The Potometer	2.1.6 use a potometer (bubble potometer and weighing method) to gain an understanding of the process of transpiration in plants;
Transpiration	2.1.7 define transpiration as evaporation from leaf cells followed by diffusion through stomata; and 2.1.8 investigate the factors affecting the rate of transpiration (wind speed, temperature, surface area and humidity) and analyse data collected to calculate the rate of transpiration.

Circulatory System

Students learn about the role of the circulatory system, along with its components and their functions. The causes of heart attacks and strokes are also explored.

Content	Learning Outcomes
B2.2 Circulatory System	In the context of how science works, students should be able to: 2.2.1 understand the role of the circulatory system as the transport of materials and protection against disease; 2.2.2 understand that the circulatory system transports blood cells (red blood cells carrying oxygen) and materials such as digested food products, carbon dioxide, hormones and urea around the body;
The Heart	2.2.3 through examining a heart: - identify the four chambers of the heart; - understand how its structure relates to the pumping action and sequence of blood flow in a double circulatory system; - identify the four blood vessels associated with the heart – the vena cava and pulmonary artery carrying deoxygenated blood and the pulmonary vein and aorta carrying oxygenated blood; and - identify the coronary blood vessels;
Blood Vessels	2.2.4 understand the role of the different types of blood vessels: - arteries – carry blood under pressure away from the heart (usually oxygenated blood); - veins – carry blood back to the heart and have valves which prevent the backflow of blood (usually deoxygenated blood); and - capillaries – allow the exchange of material with tissues through permeable walls; and 2.2.5 identify the blood vessels entering and leaving the heart, lungs, liver and kidney, and their functions.

Content	Learning Outcomes
Heart Attacks and Strokes	In the context of how science works, students should be able to: 2.2.6 understand that: - a blockage of the coronary vessels caused by the build up of cholesterol deposits restricts blood flow to the heart muscles, causing death of the heart muscle cells; - a blockage in blood vessels to the brain leads to a stroke, causing brain cell death and reduced brain function; - in both cases blockage leads to less oxygen and glucose reaching cells (heart muscle and brain) and less cell respiration; and - certain factors increase or reduce the risk of heart disease and strokes, and interpret secondary data to evaluate these risk factors (*w – (i)b*); and 2.2.7 investigate the effects of exercise on the pulse rate and know how the circulatory system benefits from regular exercise – strengthened heart muscle and increased volume of blood pumped per beat at rest (*w – all of (ii)*).

Microorganisms, Defence against Disease, Medicines and Drugs

Students learn about how diseases are caused by microorganisms and the body's defence mechanisms against disease. They explore the role of vaccinations and medicines in our lives and the adverse effects of misusing drugs.

Content	Learning Outcomes
B2.3 Microorganisms, Defence against Disease, Medicines and Drugs Types of Microorganisms	In the context of how science works, students should be able to: 2.3.1 understand the role of Pasteur's Swan Neck experiment in refuting earlier theories about spontaneous generation (*w – (iv)b, (iv)c*); 2.3.2 know the types of disease-causing microorganisms and how they are spread, prevented and treated (*w – (iii)a*), including: - bacteria (gonorrhoea, chlamydia, salmonella and tuberculosis); - viruses (HIV leading to AIDS, cold and flu, mumps, measles, polio and rubella); and - fungi (athlete's foot); and
The Body's Defence Mechanisms	2.3.3 understand the defence mechanisms of the body, to include: - the skin, mucous membranes and blood clotting; - the production of antibodies by white blood cells

Content	Learning Outcomes
	(lymphocytes) in response to antigens; and - the process of phagocytosis – engulfing and digesting microorganisms by white blood cells (phagocytes).
The Body's Defence Mechanisms (cont.)	In the context of how science works, students should be able to: 2.3.4 understand that immunity to disease is produced by raised antibody levels in the blood and that immunity can be: - natural – innate and acquired; or - artificial – active and passive;
Vaccinations	2.3.5 understand the role of vaccines, to include: - *the use of modified disease-causing organisms to produce raised antibody levels in the blood* (*w – (iii)a*); - *the role of booster vaccinations and the interpretation of graphs of blood antibody levels* (*w – (iii)b, (iii)c*); - the development of the first vaccination by Jenner as an example of how scientific understanding and theories develop (*w – all of (iv)*); and - the importance of immunisation when travelling to certain countries (specific details of immunisation programmes are not required);
Antibiotics	2.3.6 understand that antibiotics, for example penicillin, are chemicals which are used against bacterial diseases to kill bacteria or reduce their growth (*w – (iii)a*);
Antibiotic-Resistant Bacteria	2.3.7 understand the implications of the following on the health of the population (*w – (iv)a*): - *overuse of antibiotics leading to bacterial resistance, resulting in the development of 'superbugs' such as MRSA;* and - procedures used to reduce the incidence of 'superbugs' and why their eradication is difficult; 2.3.8 *use secondary data to evaluate the effectiveness of measures that have been introduced to reduce the number of infections caused by antibiotic-resistant bacteria* (*w– (ii)b, (ii)d, all of (iii)*); and
Aseptic Techniques	2.3.9 safely use aseptic techniques to inoculate, plate and incubate bacteria and investigate the effect of different antibiotics on their growth (*w – all of (ii)*).

Content	Learning Outcomes
Alcohol, Tobacco and Drugs	In the context of how science works, students should be able to: 2.3.10 understand how drugs may be used or misused: - alcohol and its effects on the individual and society: binge drinking; the effect of drinking on the development of the foetus; reasons why people drink; and evaluation of strategies for reducing alcohol intake; - tobacco smoke: tar – cause of bronchitis (narrowing of bronchi and bronchioles), emphysema (damage to alveoli reducing the surface area for gas exchange) and lung cancer (abnormal cell division); nicotine – addictive and affects heart rate; and carbon monoxide – combines with red blood cells to reduce the oxygen-carrying capacity of the blood; and - the effects of cannabis and cocaine on the individual and society;
Legislation	2.3.11 understand how scientific evidence about the use and misuse of some of the drugs listed contributes to changes in legislation in areas such as smoking bans, licensing regulations for bars and clubs, and the legal position of cannabis (*w – (iv)c*); and
Effects of Legislation	2.3.12 collect data from secondary sources on the results of the ban on smoking in relation to the incidence of lung cancer (*w – (i)a, (i)b*).

Chromosomes, Genes and DNA

Students develop an understanding of the structure and functions of chromosomes, genes and DNA.

Content	Learning Outcomes
B2.4 Chromosomes, Genes and DNA	In the context of how science works, students should be able to: 2.4.1 identify and describe chromosomes as genetic structures in the nucleus of a cell (*w – (iii)a*);
Chromosomes	2.4.2 know that chromosomes occur as functional pairs (except in sex cells) (*w – (iii)a*);
Genes	2.4.3 identify and describe genes as sections of chromosomes that operate as functional units to control characteristics (*w – (iii)a*); 2.4.4 know that genes are short lengths of DNA (*w – (iii)a*);
DNA Structure	2.4.5 understand the structure of DNA (*w – (iii)a*), to include: - a phosphate and sugar (deoxyribose) backbone with interlinking bases to form a double helix; - base pairing rules and the unique nature of an individual's DNA; and - *the link between the DNA code and the building up of amino acids in the correct sequence to form protein – the base triplet hypothesis (transcription and translation not required);* and
Discovery of DNA Structure	2.4.6 *describe (in outline only) how the work of Chargaff, Franklin and Wilkins, and Watson and Crick, using different lines of evidence, led to the discovery of the structure of DNA* (*w – (i)c, (iii)b, (iv)c*).

Cell Division and Genetics

Students investigate the processes of cell division and monohybrid genetics.

Content	Learning Outcomes
B2.5 Cell Division and Genetics	In the context of how science works, students should be able to: 2.5.1 understand that mitosis allows organisms to grow, to replace worn out cells and to repair damaged tissue;
Mitosis	2.5.2 outline mitosis in terms of the exact duplication of chromosomes producing daughter cells that are genetically identical to parent cells (clones) – names of phases and details of DNA replication not required; 2.5.3 *know that asexual reproduction in plants results in genetically identical offspring (clones) illustrated by tissue culture (in outline only);*
Meiosis	2.5.4 understand meiosis as reduction division (one cell producing four genetically different, haploid daughter cells) *and as a process which, through independent assortment, reassorts the chromosomes to provide variation (crossing over and the stages of meiosis are not required)* (*w – (iii)a*);
Fertilisation	2.5.5 understand fertilisation as a means of restoring the diploid number and combining different sets of chromosomes (*w – (iii)a*);
Genetic Diagrams and Terminology	2.5.6 understand and interpret genetic diagrams consisting of a single characteristic controlled by a single gene with two alleles (monohybrid cross) in plants, animals and humans (*w – all of (iii)*), to include: - dominant and recessive alleles; - genotype, phenotype, gamete and offspring ratios and percentages; - homozygous and heterozygous genotypes; - Punnett squares to determine genotype frequencies; and - *test (back) crosses to determine an unknown genotype;* and
The X and Y Chromosomes	2.5.7 understand how sex is determined in humans.

Reproduction, Fertility and Contraception

Students develop their understanding of human reproduction. Contraception as a mechanism for preventing pregnancy and fertility issues are also addressed.

<table>
<tr><th>Content</th><th colspan="2">Learning Outcomes</th></tr>
<tr><td>B2.6 Reproduction, Fertility and Contraception

Sperm Formation and Pregnancy</td><td colspan="2">In the context of how science works, students should be able to:</td></tr>
<tr><td></td><td>2.6.1</td><td>know that:
- sperm cells are specialised cells formed by meiosis, followed by differentiation in the testes under the influence of the hormone testosterone;
- sperm cells are adapted to their function by having a haploid nucleus and a tail for swimming;
- fertilisation takes place in the oviducts when the sperm and the haploid egg nucleus fuse to give a diploid zygote;
- the zygote divides by mitosis many times to form a ball of cells as it travels down the oviduct to the uterus;
- after implantation in the uterus lining it then differentiates to produce a variety of tissues and organs;
- the placenta is adapted for diffusion by having a large surface area for exchange of dissolved nutrients, oxygen, carbon dioxide and urea;
- these substances are carried to or from the foetus in the blood vessels in the umbilical cord; and
- the amnion and amniotic fluid cushion the foetus;</td></tr>
<tr><td>Sex Hormones</td><td>2.6.2</td><td>know that testosterone (produced by the testes) and oestrogen (produced by the ovaries) are sex hormones and recall the secondary sexual characteristics they cause to develop;</td></tr>
<tr><td>Menstrual Cycle</td><td>2.6.3</td><td>describe the events of the menstrual cycle – menstruation, ovulation and the period when fertilisation is most likely to occur;</td></tr>
<tr><td>Infertility</td><td>2.6.4</td><td>explain some of the causes of infertility and developments in fertility treatment (w – (iv)a):
- the use of hormones to produce multiple ova;
- in vitro fertilisation; and
- the transfer of several embryos into the uterus; and</td></tr>
<tr><td></td><td>2.6.5</td><td>understand some of the controversy associated with these techniques and their ethical implications (w – (iv)a, (iv)b).</td></tr>
</table>

Content	Learning Outcomes
Contraception	In the context of how science works, students should be able to: 2.6.6 examine how different methods of contraception work and evaluate the advantages and disadvantages of each (*w – (iv)a*, *(iv)b*), to include: - mechanical – the condom as a barrier to prevent the passage of sperm and also prevent the spread of sexually transmitted infections, some of which can lead to infertility if left untreated (gonorrhoea, chlamydia and HIV leading to AIDS); - chemical – the contraceptive pill that changes hormone levels and stops the development of the ovum; - surgical – male and female sterilisation to prevent the passage of sperm and ova respectively; and - an awareness that contraception can raise ethical issues for some people.

Applied Genetics

Students understand that mutations can occur in genetic codes, and they investigate the opportunities and moral issues that are linked to our developing understanding in this area. They also learn about genetic engineering.

Content	Learning Outcomes
B2.7 Applied Genetics	In the context of how science works, students should be able to: 2.7.1 recall that cystic fibrosis is an inherited disease;
Mutations	2.7.2 understand that mutations are random changes in the: - number of chromosomes (Down Syndrome); or - structure of genes and can be triggered by environmental factors, such as UV light causing skin cancer; and
Genetic Screening	2.7.3 understand the principles of genetic screening during pregnancy and be aware of the ethical issues it raises (*w – (iv)b*).

Content	Learning Outcomes
Genetic Engineering	In the context of how science works, students should be able to: 2.7.4 understand genetic engineering (*w – all of (iii)*), to include: - the basic techniques used to produce human insulin (for the treatment of diabetes) – transfer of a human insulin gene into a plasmid of a bacterial cell to form a genetically modified bacterium which then multiplies and produces human insulin; and - the advantages of producing human insulin (and other products) by this method (*w – (iv)a, (iv)b*).

Variation and Selection

Students develop an understanding of the nature of variation in living organisms and the relationship between variation and selection.

Content	Learning Outcomes
B2.8 Variation and Selection Types of Variation	In the context of how science works, students should be able to: 2.8.1 investigate variation in living things, display data using appropriate graphical techniques, and evaluate the validity and reliability of the data (*w – all of (i), all of (ii)*), to include: - height and mass as examples of continuous variation (histogram) (*w – (iii)c*); and - tongue rolling as an example of discontinuous variation (bar chart) (*w – (iii)c*); 2.8.2 understand that variation in living organisms has both a genetic and an environmental basis (for example height in humans) (*w – (iii)a*); and
Natural Selection	2.8.3 understand how variation and selection may lead to evolution or extinction (*w – (iii)a*), to include: - natural selection as variation within phenotypes and competition for resources often leading to differential survival, for example antibiotic resistance; - survival of the fittest in terms of those best adapted being more likely to survive to reproduce and pass on their genes to the next generation, using this model to explain secondary data; - the possibility of failure to adapt resulting in extinction of a species over time; and - *the relationship between natural selection and evolution as a continuing process which leads to gradual changes in organisms over time.*

3.3 Chemistry Unit 1 (C1): Structures, Trends and Chemical Reactions

Note that the Equations section details chemical reactions that can be assessed throughout the subject content (Units C1 and C2).

Content	Learning Outcomes
C1.1 Hazard Symbols	In the context of how science works, students should be able to: 1.1.1 develop an awareness of the importance of safety in the laboratory to assess potential risk including the hazards associated with chemicals labelled with the GHS/CLP international chemical hazards labelling. The following hazard symbols should be known: toxic, corrosive, flammable, explosive and caution.

Elements, Compounds and Mixtures

Students examine the differences between elements, compounds and mixtures.

Content	Learning Outcomes
C1.2 Elements, Compounds and Mixtures	In the context of how science works, students should be able to: 1.2.1 describe an element as a substance that consists of only one type of atom; 1.2.2 understand that elements cannot be broken down into simpler substances by chemical means; 1.2.3 define a compound as a substance that consists of two or more different elements chemically bonded together; 1.2.4 investigate practically that a mixture consisting of two or more substances can be easily separated, for example iron and sulfur, salt and sand; 1.2.5 identify elements and compounds as solids, liquids and gases (at room temperature and pressure) and understand the terms evaporation, boiling, melting, condensation, sublimation, freezing, melting point and boiling point; 1.2.6 understand the terms soluble, insoluble, solute, solvent, solution, residue, filtrate, distillate, miscible and immiscible; and 1.2.7 interpret given data to classify substances as elements (metals and non-metals), compounds or mixtures and distinguish between them according to their properties (metallic properties to include conduction of heat and electricity, ductility, malleability, melting point and sonority) (*w – (i)a*).

Periodic Table

Students investigate how attempts to classify elements in a systematic way, including those of Newlands and Mendeleev, have led, through the growth of chemical knowledge, to the modern Periodic Table. Students also examine important features of the Periodic Table and trends in Groups 1 (I) and 7 (VII).

Content	Learning Outcomes
C1.3 Periodic Table History of Development	In the context of how science works, students should be able to: 1.3.1 evaluate the work of Newlands (Law of Octaves) in the development of the Periodic Table and recognise the uncertainties and limitations of his theory (*w – (iv)c*); 1.3.2 be aware that Mendeleev, in developing the modern form of the Periodic Table, observed recurring patterns in the properties of elements when arranged in order of increasing atomic mass but used creative thought to realise that he needed to leave gaps for elements which had not been discovered at that time, and that this enabled him to predict properties of undiscovered elements (*w – (i)b, (i)c, (iv)c*); 1.3.3 understand how scientific ideas have changed over time in terms of the differences and similarities between Mendeleev's Periodic Table and the modern Periodic Table (*w – (iv)c*);
Basic Structure of the Periodic Table	1.3.4 understand that a group is a vertical column in the Periodic Table and a period is a horizontal row; 1.3.5 identify and recall the position of metals and non-metals in the Periodic Table; 1.3.6 locate the positions in the Periodic Table of the alkali metals, the alkaline earth metals, the halogens, the noble gases and the transition metals; 1.3.7 interpret data about the electronic structure of an atom to deduce the group that an element belongs to (*w – (i)a*); 1.3.8 recall that elements with similar properties appear in the same group, for example Group 1 (I) is a group of reactive metals, Group 7 (VII) is a group of reactive non-metals, and Group 8 (VIII) is a group of non-reactive non-metals; and 1.3.9 use the concept of electronic configuration to explain the lack of reactivity and the stability of the noble gases (*w – (i)c*).

Content	Learning Outcomes
Basic Structure of the Periodic Table (cont.)	In the context of how science works, students should be able to: 1.3.10 collect and analyse scientific data by examining the reactions of Group 1 (I) elements with water *and with Group 7 (VII) elements* to identify patterns of reactivity in Group 1 (I) *(w – (i)a, (ii)b)*;
Group 1 (I)	1.3.11 assess and manage risks associated with storage and use of alkali metals and recall that alkali metals are easily cut, shiny when freshly cut and tarnish rapidly in air; 1.3.12 *understand that alkali metals have similar chemical properties because when they react an atom loses an electron to form a positive ion with a stable electronic configuration;*
Group 7 (VII)	1.3.13 recall data about the colour, physical state at room temperature and pressure, diatomicity and toxicity of the elements in Group 7 (VII), *interpret given data to establish trends within the group, and make predictions based on these trends* (*w – (i)b*); 1.3.14 recall the observations when solid iodine sublimes on heating; 1.3.15 *understand that the halogens have similar chemical properties because when they react an atom gains an electron to form a negative ion with a stable electronic configuration; and* 1.3.16 *investigate the displacement reactions of Group 7 (VII) elements with solutions of other halides to establish the trend in reactivity within the group and make predictions based on this trend* (*w – (i)a, (ii)a*).

Water, Solubility and Solubility Curves

Students investigate the properties of water. They also investigate and study experimentally the solubilities of substances, using appropriate scientific terms.

Content	Learning Outcomes
C1.4 Water, Solubility and Solubility Curves	In the context of how science works, students should be able to: 1.4.1 investigate practically the physical properties of water (limited to state at room temperature and pressure, colour, melting point and boiling point) and its use as a solvent; 1.4.2 use anhydrous copper(II) sulfate to test for water; 1.4.3 understand the terms solvent, solute, solution, anhydrous and hydrated; 1.4.4 define solubility as the mass of solid required to saturate 100 g of water at a particular temperature; 1.4.5 collect solubility data for a range of salts and use this data to deduce the general rules that describe the solubility of simple salts (as given on the Data Leaflet) (*w – (i)a, (ii)a, (ii)c*); 1.4.6 use given data to calculate solubility values (*w – (iii)b*); 1.4.7 recall that most ionic compounds are soluble in water and many covalent compounds are insoluble in water; 1.4.8 understand that the solubility of gases decreases as temperature increases; 1.4.9 explain the effects of thermal pollution on the dissolved oxygen content of water and on aquatic life; 1.4.10 understand that the solubility of most solids increases as temperature increases; 1.4.11 understand that a saturated solution is one in which no more solute will dissolve at that temperature, *and when a hot concentrated solution is cooled some of the solute is deposited, and calculate the mass of the solute deposited;* 1.4.12 experimentally determine the solubility of a solid in water (*w – (ii)c, (iii)c*); and 1.4.13 draw and interpret solubility curves (graph of solubility in g/100 g water against temperature in ˚C) (*w – (i)a, (iii)a, (iii)b*).

Atomic Structure

Students learn about atomic structures. They begin to understand that all chemical elements are made up of atoms that consist of nuclei and electrons. They use data to deduce the number and arrangement of the subatomic particles in atoms, ions and isotopes.

Content	Learning Outcomes
C1.5 Atomic Structure	In the context of how science works, students should be able to: 1.5.1 describe the structure of an atom as a central nucleus containing protons and neutrons surrounded by orbiting electrons in shells; 1.5.2 state the relative charges and relative masses of protons, neutrons and electrons; 1.5.3 define atomic number as the number of protons in an atom; 1.5.4 define mass number as the total number of protons and neutrons in an atom; 1.5.5 analyse data given in the Periodic Table to write and draw the electronic structure (electronic configuration) of atoms and ions (elements with atomic number 1–20) (*w – (i)a*); 1.5.6 interpret given data to deduce the number of protons, neutrons and electrons present in an atom or ion and to determine the charge on an ion or determine the number of subatomic particles given the charge (*w – (i)a*); 1.5.7 understand that the atom as a whole has no electrical charge because the number of protons is equal to the number of electrons; 1.5.8 define isotopes as atoms of an element with the same atomic number but a different mass number, indicating a different number of neutrons; and 1.5.9 interpret data on the number of protons, neutrons and electrons to identify isotopes of an element (*w – (i)a*).

Bonding

The arrangement of electrons in atoms can be used to explain what happens when elements react. Students examine ionic, covalent and metallic bonding.

Content	Learning Outcomes
C1.6 Bonding Ionic Bonding	In the context of how science works, students should be able to:
	1.6.1 understand that an ion is a charged particle formed when an atom gains or loses electrons, and a molecular ion is a charged particle containing more than one atom;
	1.6.2 *define the terms cation and anion;*
	1.6.3 use the scientific theory of atomic structure to explain, diagrammatically (using dot and cross diagrams) or otherwise, how ions are formed and how ionic bonding takes place in simple ionic compounds (restricted to elements in Groups 1 (I) and 2 (II) with elements in Groups 6 (VI) and 7 (VII), the ions of which have a noble gas electronic structure) (*w – (i) c*);
	1.6.4 understand that ionic bonding involves attraction between oppositely charged ions, that ionic bonds are strong and that substantial energy is required to break ionic bonds;
	1.6.5 recognise that ionic bonding is typical of metal compounds;
Covalent Bonding	1.6.6 describe a single covalent bond as a shared pair of electrons;
	1.6.7 use the scientific theory of atomic structure to explain diagrammatically (using dot and cross diagrams) how covalent bonding occurs in H_2, Cl_2, HCl, H_2O, NH_3, CH_4 and similar molecules, and be able to label lone pairs of electrons (*w – (i)c*);
	1.6.8 *draw dot and cross diagrams and indicate the presence of multiple bonds in* O_2, N_2 *and* CO_2;
	1.6.9 recognise covalent bonding as typical of non-metallic elements and compounds;
	1.6.10 understand that a molecule is two or more atoms covalently bonded and that diatomic means that there are two atoms covalently bonded in the molecule; and
	1.6.11 understand that covalent bonds are strong and substantial energy is required to break covalent bonds.

Content	Learning Outcomes
Metallic Bonding	In the context of how science works, students should be able to: 1.6.12 *understand that metallic bonding results from the attraction between the positive ions in a regular lattice and the delocalised electrons.*

Structures

Students examine the structural models of ionic lattices, molecular covalent, giant covalent and metallic structures. They use these accepted models to explain the properties and uses of the different structures.

Content	Learning Outcomes
C1.7 Structures	In the context of how science works, students should be able to:
Ionic Structures	1.7.1 use the accepted structural model for ionic lattices to predict and explain where appropriate the physical properties of ionic substances such as sodium chloride (including melting point, boiling point, solubility in water and electrical conductivity) – diagram of ionic lattice is not expected (*w – (i)c*);
Molecular Covalent Structures	1.7.2 use the accepted structural model for molecular covalent structures to predict and explain where appropriate the physical properties of molecular covalent structures such as iodine and carbon dioxide (including melting point, boiling point, solubility in water and electrical conductivity) (*w – (i)c*);
Giant Covalent Structures	1.7.3 use and describe the accepted models for the giant covalent structures carbon (diamond) and carbon (graphite) to predict and explain where appropriate their physical properties (including electrical conductivity, hardness, melting point, boiling point and solubility in water) and their uses in cutting tools (diamond), lubricants and pencils (graphite) (*w – (i)c*); 1.7.4 understand the meaning of the term allotrope as applied to carbon (diamond) and carbon (graphite); and
Metallic Structures	1.7.5 *use the accepted structural model for metals to predict and explain where appropriate their structure and physical properties (including melting point, malleability, ductility and electrical conductivity)* (*w – (i)c*).

Content	Learning Outcomes
Metallic Structures (cont.)	In the context of how science works, students should be able to: 1.7.6 *interpret given data to distinguish between metals and non-metals* (*w – (i)a*);
Alloys	1.7.7 understand that an alloy is a mixture of two or more elements, at least one of which is a metal, and that the resulting mixture has metallic properties;
Uses of Metals	1.7.8 recall uses of metals and relate these uses to their properties, including: – aluminium (overhead electrical wiring and alloys for aircraft); – copper (electrical wiring, plumbing, brass and coinage); – iron (bridges and structures); and – magnesium (flares and high strength alloys for aircraft); and
Classification of Structures	1.7.9 *interpret given data to classify the structure of substances as ionic lattice, molecular covalent, giant covalent or metallic.*

Equations

In this section students develop skills of writing formulae and writing and balancing symbol equations. This section may be tested throughout the specification, both in C1 and in C2.

Content	Learning Outcomes
C1.8 Equations Symbols and Formulae	In the context of how science works, students should be able to: 1.8.1 recognise symbols and names for common elements and recall the diatomic elements; 1.8.2 interpret chemical formulae by naming the elements and stating the number of each type of atom present (*w – (iii)a, (iii)c*); and 1.8.3 apply scientific data, in the form of symbols, valencies, position in the Periodic Table and formulae of molecular ions, and write chemical formulae of compounds (*w – (iii)a, (iii)c*).

Content	Learning Outcomes
Chemical Equations	In the context of how science works, students should be able to: 1.8.4 understand that chemical reactions use up reactants and produce new substances called products; 1.8.5 construct word equations to describe the range of reactions covered in the specification; 1.8.6 recognise that in a chemical reaction (change) no atoms are lost or made but they are rearranged, and as a result we can write balanced symbol equations showing the atoms involved; 1.8.7 write balanced symbol equations for all reactions covered in the specification; 1.8.8 apply scientific skills to write and balance symbol equations for unfamiliar chemical reactions when the names of the reactants and products are specified (*w – (iii)a, (iii)c*); and 1.8.9 *write ionic equations for simple reactions, to include reactions detailed in the specification* (*w – (iii)c*).

Acids, Bases and Salts

This section focuses on the classification of substances as acids and alkalis and how acids react with bases, carbonates and metals. Students experimentally explore appropriate methods to prepare soluble salts.

Content	Learning Outcomes
C1.9 Acids, Bases and Salts	In the context of how science works, students should be able to: 1.9.1 understand and describe the use of indicator papers (red and blue litmus papers and universal indicator paper); and
Indicators and pH	1.9.2 interpret given data about universal indicator (colour/pH) to classify solutions as acidic/alkaline/neutral and to indicate the relative strengths of acidic and alkaline solutions (the classification for these solutions should be: - pH 0–2 strong acid; - pH 3–6 weak acid; - pH 7 neutral; - pH 8–11 weak alkali; and - pH 12–14 strong alkali) (*w – (iii)a*).

Content	Learning Outcomes
Strength of Acids and Alkalis	In the context of how science works, students should be able to:
	1.9.3 recall examples of strong acids (to include hydrochloric and sulfuric acid), weak acids (to include ethanoic acid), strong alkalis (to include sodium hydroxide) and weak alkalis (to include ammonia);
	1.9.4 evaluate the validity and reliability of data collection using a pH meter, universal indicator paper, and red and blue litmus paper (*w – (ii)d*);
	1.9.5 understand that dilute and concentrated solutions of acids and alkalis vary in their concentration and that concentration is measured in mol/dm^3;
	1.9.6 understand that acids dissolve in water to produce hydrogen ($H^+_{(aq)}$) ions;
	1.9.7 understand that alkalis dissolve in water to produce hydroxide ($OH^-_{(aq)}$) ions;
Neutralisation	1.9.8 know that neutralisation involves the reaction of a base or alkali with an acid to make a salt and water only (*w – (i)b, (iii)a*);
	1.9.9 *describe neutralisation as the reaction between the hydrogen ions in an acid and the hydroxide ions in an alkali to produce water* $$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$
	1.9.10 recall that a base is a metal oxide or hydroxide which neutralises an acid to produce a salt and water and that an alkali is a soluble base;
Reactions of Acids	1.9.11 describe and investigate the reactions of acids with bases to produce a salt and water (limited to hydrochloric acid and sulfuric acid with bases including sodium hydroxide, calcium hydroxide, copper oxide and magnesium oxide) and with metal carbonates including calcium carbonate and copper(II) carbonate; and
	1.9.12 describe the reactions of acids (limited to hydrochloric acid and sulfuric acid) with metals to produce a salt and hydrogen.

Content	Learning Outcomes
Salts	In the context of how science works, students should be able to: 1.9.13 know that copper(II) oxide is black, copper(II) carbonate is green and hydrated copper(II) sulfate is blue and that copper salts are usually blue in solution; 1.9.14 know that most Group 1 (I), Group 2 (II) and aluminium compounds are white and if they dissolve in water they give colourless solutions;
Gas Tests	1.9.15 describe how to test for hydrogen gas – apply a lighted splint and a popping sound results (equation for reaction required); and 1.9.16 describe how to test for carbon dioxide: limewater (calcium hydroxide solution) will change from colourless to milky if the test is positive.

Electrolysis

Students learn to use the key terms associated with electrolysis and study electrolysis of molten ionic compounds.

Content	Learning Outcomes
C1.10 Electrolysis	In the context of how science works, students should be able to: 1.10.1 explain the meaning of the terms electrolysis, inert electrode, anode, cathode and electrolyte and explain conduction in an electrolyte (solution or molten) in terms of ions moving and carrying charge (*w – (i)c*); 1.10.2 predict the products of electrolysis of molten salts including lithium chloride and lead(II) bromide using graphite electrodes, and state appropriate observations at the electrodes (solution electrolysis not required) (*w – (iii)a*); and 1.10.3 *interpret and write half equations for the reactions occurring at the anode and cathode for the electrolysis of molten lithium chloride and lead(II) bromide and for other molten metal halides* (*w – (iii)c*).

Content	Learning Outcomes
Extraction of Aluminium	In the context of how science works, students should be able to: 1.10.4 describe the industrial extraction of aluminium from alumina: - understand that alumina has been purified from the ore bauxite; - *write and interpret half equations for the reactions taking place at the anode and the cathode; and* - understand the need to replace the anodes periodically (*w* – *(iii)b*); 1.10.5 *evaluate the high cost of the process to manufacture aluminium and how these costs are minimised (to include the use of cryolite to reduce operating temperature and increase conductivity and the aluminium oxide crust to keep the heat in)* (*w* – *(iv)b*); 1.10.6 know that recycling aluminium uses only a fraction of the energy needed to extract it from bauxite and saves waste; and 1.10.7 *discuss the factors affecting the siting of an aluminium extraction plant* (*w* – *(iv)b*).

3.4 Chemistry Unit 2 (C2): Further Chemical Reactions and Organic Chemistry

Reactivity Series of Metals

Students study experimentally the reactions of metals with water, air (oxygen) and solutions containing other metal ions and from this data construct a reactivity series. Knowledge of the reactivity series is useful in predicting chemical properties of other metals.

Content	Learning Outcomes
C2.1 Reactivity Series of Metals	In the context of how science works, students should be able to: 2.1.1 recall the reactivity series of metals, to include K, Na, Ca, Mg, Al, Zn, Fe and Cu; 2.1.2 describe the reactions of: - K, Na and Ca with cold water; and - Mg, Al, Zn and Fe with steam, and how to collect the gas produced, where appropriate; 2.1.3 describe the reactions of Ca, Mg, Al, Zn, Fe and Cu with air (oxygen); 2.1.4 explain and describe the displacement reactions of metals with other metal ions in solution; 2.1.5 collect and/or analyse experimental data to predict where an unfamiliar element should be placed in the reactivity series or to make predictions about how it will react (*w – (i)a, (i)b, (iii)a*); 2.1.6 examine the relationship between the extraction of a metal from its ore and its position in the reactivity series: for example aluminium, a reactive metal, is extracted by electrolysis, and iron, a less reactive metal, by chemical reduction with carbon or carbon monoxide; 2.1.7 know that the extraction of a metal from its ore (usually an oxide) requires the process of reduction; 2.1.8 describe the extraction of iron from haematite, including: - *the production of the reducing agent;* - the reduction of haematite; and - *the removal of acidic impurities*; and 2.1.9 *recognise and explain important oxidation and reduction reactions in iron manufacture.*

Rusting, Oxidation and Reduction

Students investigate rusting and other oxidation and reduction reactions. They understand methods of rust prevention and the importance of redox reactions in industrial processes.

Content	Learning Outcomes
C2.2 Rusting, Oxidation and Reduction	In the context of how science works, students should be able to: 2.2.1 investigate experimentally rusting as the reaction of iron with water and air producing ***hydrated iron(III) oxide*** (*w – (i)a, (ii)a*);
Rusting	2.2.2 understand the methods used to protect iron from rusting, to include barrier methods, for example painting, oiling, plastic coating and suitable metal coating/plating (including galvanising) ***and explain sacrificial protection of iron related to the reactivity series*** (*w – (iv)a*);
Redox	2.2.3 recognise oxidation as the addition of oxygen to, or removal of hydrogen from, a substance (reduction as the reversal of oxidation); 2.2.4 relate important oxidation and reduction reactions to everyday examples (including rusting and combustion of fuels) and recognise oxidation and reduction from balanced symbol equations (*w – (i)b, (i)c*); 2.2.5 investigate experimentally: - reduction of copper(II) oxide using hydrogen; and - burning of magnesium and sulfur in air (oxygen) (*w – (i)a, (ii)b, (ii)c*); 2.2.6 ***recognise and explain redox as a process involving electron transfer and be able to identify and explain the oxidation and reduction processes from a redox equation*** (*w – (i)b, (iii)a*); and 2.2.7 ***recognise and explain important oxidation and reduction reactions in industrial processes, to include iron and aluminium manufacture, and the Haber process.***

Hard and Soft Water

Students examine hard and soft water, including advantages and disadvantages of each and the chemistry involved in softening hard water.

Content	Learning Outcomes
C2.3 Hard and Soft Water	In the context of how science works, students should be able to: 2.3.1 understand that soft water readily forms lather with soap and hard water reacts with soap to form scum, so hard water requires more soap to form lather; 2.3.2 describe the effect of hard water on detergents; 2.3.3 understand the differences between temporary and permanent hardness in water; 2.3.4 plan and carry out experiments to identify a sample of water as hard or soft and to determine the type of hardness, using soap solution (*w – (ii)a, (iii)c*); 2.3.5 understand that hard water is caused by dissolved calcium and/or magnesium ions and explain how temporary hardness arises in water; 2.3.6 evaluate the advantages and disadvantages of hard water, to include the increased cost due to waste of soap, use of dishwasher salt, production of limescale, health advantages and use in the brewing industry (*w – (iv)b*); 2.3.7 *explain how the methods of boiling and ion exchange soften hard water;* 2.3.8 *understand that a precipitation reaction involves the ions in two solutions reacting together to make an insoluble substance; and* 2.3.9 *relate the term precipitation to the softening of hard water by addition of hydrated sodium carbonate (washing soda) – ionic equation including state symbols is required.*

Quantitative Chemistry

In this section, students examine calculations involving solid substances. They should be able to deduce relative molecular masses and use moles to determine reacting masses.

Content	Learning Outcomes
C2.4 Quantitative Chemistry	In the context of how science works, students should be able to: 2.4.1 recall that the relative atomic mass of an atom is the mass of the atom compared with that of the carbon-12 isotope, which has a mass of exactly 12; 2.4.2 collect and use quantitative data from the Periodic Table to calculate relative formula masses (relative molecular masses) (*w – (i)a, (iii)b*); 2.4.3 understand that the relative formula mass of a substance in grams is known as one mole of that substance; 2.4.4 convert the given mass of a substance to the amount of the substance in moles (and vice versa) by using the relative atomic or formula masses (*w – (iii)b*); 2.4.5 understand the importance of scale in chemistry in terms of calculating moles from masses given in tonnes and kilograms, for example in industrial processes; 2.4.6 *understand that no atoms are lost or made in a chemical reaction and hence it is possible to interpret equations quantitatively;*
Percentage Composition and Moles	2.4.7 *calculate the reacting masses of reactants or products, given a balanced symbol equation and using moles and simple ratio* (*w – (i)a, (iii)b*);
Solution Concentration	2.4.8 *understand the term concentration of a solution expressed in moles per litre (mol/dm^3) – questions on titrations will not be asked, but concentrations of chemicals in solution may be given in moles per litre (mol/dm^3) if this is appropriate; and* 2.4.9 *understand that when a solution is diluted the concentration changes but the total number of moles of solute does not, for example when 100 cm^3 of 0.2 mol/dm^3 solution of hydrochloric acid is diluted with deionised water to 200 cm^3, the new concentration is 0.1 mol/dm^3.*

Rates of Reaction

Students investigate and study experimentally the factors which affect the rates of compound reactions.

Content	Learning Outcomes
C2.5 Rates of Reaction	In the context of how science works, students should be able to: 2.5.1 describe the qualitative effects of temperature, concentration, particle size and catalysis on the rate of a chemical reaction; 2.5.2 understand that the rate of a reaction may be determined by measuring the loss of a reactant or gain of a product over time and use the equation $\text{rate} = \frac{1}{\text{time}}$ 2.5.3 plan appropriate methods to measure the rate of the chemical reaction and collect reliable data (methods limited to measuring a change in mass or gas volume against time); the reactions studied should include: - metals with dilute acid; - marble chips with dilute hydrochloric acid; and - catalytic decomposition of hydrogen peroxide (*w – (i)a, (ii)a*); 2.5.4 interpret rate data quantitatively, for example drawing graphs and making predictions about how the rate of reaction may change when one of the list of factors is altered (*w – (i)b, (iii)b*); 2.5.5 make predictions and investigate the effects of changing concentration, particle size and temperature and adding a catalyst on the rates of chemical reactions, using ICT where appropriate (*w – (i)a, (ii)a, (ii)b*); 2.5.6 *use the collision theory to explain how the factors identified above influence the rate of a chemical reaction* (*w – (i)c, (iii)c*); and 2.5.7 understand that a catalyst is a substance which increases the rate of a reaction without being used up.

Energetics

This section looks at energy changes that take place in chemical reactions.

Content	Learning Outcomes
C2.6 Energetics	In the context of how science works, students should be able to: 2.6.1 understand that reactions in which heat is given out are exothermic and that reactions in which heat is taken in are endothermic, for example neutralisation, thermal decomposition, combustion, rusting, displacement and hydration of copper(II) sulphate (*w – (i)b, (iii)a*); 2.6.2 recall that bond breaking takes in energy and bond making releases energy, ***and understand that the overall energy change in a reaction is a balance of the energy taken in when bonds break in the reactants and the energy released when bonds form in the products;***
Thermal Decomposition	2.6.3 define thermal decomposition as the breakdown of a compound using heat, and describe the effect of heat on metal carbonates, for example calcium carbonate and copper carbonate (*w – (i)a, (iii)a*); 2.6.4 understand that limestone ($CaCO_3$) undergoes thermal decomposition in a lime kiln ***and is used in the blast furnace to remove acidic impurities;*** 2.6.5 know that limestone is quarried and is used both as a building material and to neutralise soil acidity; and 2.6.6 evaluate the socio-economic and environmental effects of limestone quarrying (*w – (iv)b*).

Non-Metals and Their Compounds

This section involves carrying out simple tests to identify a range of gases. Students also study aspects of the chemistry of important non-metals and some of their compounds.

Content	Learning Outcomes
C2.7 Non-Metals and Their Compounds	In the context of how science works, students should be able to: 2.7.1 use the following tests in problem-solving situations to plan and carry out procedures to identify the gases (the test and expected positive result for each is given): - hydrogen test: apply a lighted splint – result: popping sound; - oxygen test: apply a glowing splint – result: it relights; - carbon dioxide test: use limewater – result: it changes from colourless to milky; and - water test: use anhydrous copper(II) sulfate (paper) – result: it turns blue;
Hydrogen	2.7.2 describe the laboratory preparation and collection of hydrogen using zinc and hydrochloric acid, and recall the diatomicity and the physical properties of hydrogen (*w – (iii)a*); 2.7.3 understand the reactions of hydrogen as a reducing agent, for example with oxygen to form water, with copper(II) oxide ***and with nitrogen to form ammonia***, and its potential use as a clean fuel; 2.7.4 recall the use of hydrogen in: - meteorological balloons; and - rocket engines;
Carbon and Carbon Dioxide	2.7.5 describe the combustion of carbon to carbon monoxide and carbon dioxide in a limited and plentiful supply of air respectively and realise the toxic effects of carbon monoxide caused by incomplete combustion of fuels; 2.7.6 recall the physical properties of carbon dioxide; and 2.7.7 investigate the reactions of carbon dioxide with water to form carbonic acid, and with calcium hydroxide solution (limewater) until carbon dioxide is in excess.

Content	Learning Outcomes
Carbon and Carbon Dioxide (cont.)	In the context of how science works, students should be able to: 2.7.8 realise that the release of carbon dioxide by burning fossil fuels increases the level of carbon dioxide in the atmosphere, appreciate that there is debate over whether this leads to global warming – the greenhouse effect – and recall effects of global warming (*w – (iv)b*); 2.7.9 using data on the properties of carbon dioxide, explain its use in: - fire extinguishers; - carbonated drinks; and - dry ice; 2.7.10 understand that during the first billion years of the Earth's existence there was intense volcanic activity which released gases that formed the early atmosphere; 2.7.11 understand that scientists have developed theories to answer questions about the Earth's atmosphere; one theory suggests that it was mainly carbon dioxide and this composition changed as living organisms evolved and carbon dioxide became locked in carbonates and fossil fuels (*w – (i)d*);
Nitrogen and Ammonia	2.7.12 recall the physical properties and diatomicity of nitrogen and describe the lack of reactivity of nitrogen; 2.7.13 recall that nitrogen is used: - as a coolant; - in food packaging; and - in manufacture of ammonia; 2.7.14 recall that ammonia is used in the: - manufacture of fertilisers; - production of nitric acid; and - manufacture of nylon; 2.7.15 recall the conditions (approximate temperature and pressure and name of catalyst) required in the Haber process *and understand that the process involves a reversible reaction between nitrogen and hydrogen forming ammonia; and* 2.7.16 *recognise and explain the important reduction reaction in the Haber process.*

Content	Learning Outcomes
Oxygen	In the context of how science works, students should be able to: 2.7.17 recall the diatomicity and physical properties of oxygen; 2.7.18 investigate safely and accurately the reaction of oxygen with hydrogen, carbon, sulfur, magnesium, zinc, iron and copper (*w – (ii)c*); 2.7.19 describe combustion as the reaction of fuels with oxygen, forming oxides and releasing energy; 2.7.20 recall that oxygen is used in: - breathing apparatus; - steel making; - welding; and - rocket engines; 2.7.21 know the proportion of different gases in the atmosphere: - about four-fifths (80%) nitrogen; - about one-fifth (20%) oxygen; and - small proportions of various other gases including carbon dioxide, water vapour and noble gases (*w – (i)c*);
Sulfur	2.7.22 recall the physical properties of sulfur; 2.7.23 describe the combustion of sulfur to form sulfur dioxide and the reaction of iron and sulfur, and recall the physical properties of sulfur dioxide; 2.7.24 understand that sulfur dioxide from the combustion of fossil fuels reacts with water in the air to form acid rain and describe the socio-economic and environmental effects of acid rain, to include: - corrosion of limestone buildings and statues; - killing fish in rivers and lakes; and - defoliating trees (w – (iv)b); and 2.7.25 describe the measures used to prevent acid rain, including removing sulfur from fuels before combustion, burning less fossil fuels, and removing sulfur dioxide from industrial and vehicle emissions (*w – (iv)b*).

Organic Chemistry

In this section, students examine the importance of oil to the chemical industry. They investigate the reactions of some simple carbon compounds. Students also study the importance of hydrocarbons and ethanol as fuels and the production and uses of polymers from alkenes.

Content	Learning Outcomes
C2.8 Organic Chemistry	In the context of how science works, students should be able to: 2.8.1 understand the terms fossil fuel, renewable resource and non-renewable resource;
Hydrocarbons	2.8.2 know that the chemicals obtained from crude oil are called hydrocarbons and that a hydrocarbon is a molecule consisting of carbon and hydrogen atoms only; 2.8.3 describe the separation of crude oil by fractional distillation into its different fractions, for example refinery gases, petrol, naphtha, kerosene, diesel oil and bitumen; 2.8.4 evaluate the environmental implications of oil spillages (*w – (i)a, (iv)b*);
Homologous Series	2.8.5 define a homologous series as a family of organic molecules that have the same general formula, show similar chemical properties, show a gradation in their physical properties and differ by a 'CH_2' unit; 2.8.6 understand the term homologous series applied to: - alkanes (C_nH_{2n+2}); - alkenes (C_nH_{2n}); - *alcohols ($C_nH_{2n+1}OH$); and* - *carboxylic acids ($C_nH_{2n+1}COOH$)* (names, molecular formulae, structural formulae and physical state at room temperature and pressure are to include the first four alkanes, the first two alkenes, *methanol, ethanol, methanoic acid and ethanoic acid*);
Functional Groups	2.8.7 understand that a functional group is a reactive group in a molecule and recognise the functional group in alkenes (C=C), *alcohols (-O-H) and carboxylic acids (-COOH)*, and realise that alkanes do not have a functional group, which makes them less reactive organic molecules; and 2.8.8 *plan an experiment to determine the presence of C=C in a variety of organic compounds using bromine water* (*w – (ii)a*).

Content	Learning Outcomes
Fuels and Combustion	In the context of how science works, students should be able to: 2.8.9 understand that complete combustion of hydrocarbons *and of alcohols* produces carbon dioxide and water and that incomplete combustion of hydrocarbons *and of alcohols* produces carbon monoxide and water and sometimes carbon (soot) – equations for the production of soot are not required; 2.8.10 describe the combustion of alkanes, *alkenes and alcohols*, to include observations and tests to identify the products; 2.8.11 evaluate the use of hydrocarbon fuels, cleaner fuels and alternative energy sources in terms of socio-economic, environmental, technological and ethical grounds (*w – (iv)a, (iv)b*);
Addition Polymerisation	2.8.12 describe how monomers, for example ethene or chloroethene (vinyl chloride), can join together to make very long chain molecules called polymers and the process is known as addition polymerisation; 2.8.13 *write equations for the polymerisation of ethene and chloroethene (vinyl chloride);* 2.8.14 *relate the uses of polythene and PVC to their properties and compare the properties of polymers to traditional materials* (*w – (iv)b*); 2.8.15 understand that addition polymers are non-biodegradable and evaluate the advantages and disadvantages of their disposal by landfill and incineration (*w – (iv)a, (iv)b*);
Alcohols	2.8.16 know that ethanol is used in alcoholic drinks, as a solvent and as a fuel; 2.8.17 *recall the preparation of ethanol from ethene and steam (conditions not required) and write a symbol equation for this reaction;* 2.8.18 describe the preparation of ethanol from sugars by fermentation (equation for fermentation of sugars not required); and 2.8.19 discuss the social impact and harmful effects of ethanol in alcoholic drinks.

Content	Learning Outcomes
Ethanoic Acid	In the context of how science works, students should be able to: 2.8.20 *know that ethanoic acid is a carboxylic acid and can be described as a weak acid;* 2.8.21 investigate experimentally the reactions of ethanoic acid with sodium carbonate, sodium hydroxide and magnesium and test any gas produced; and 2.8.22 recall that a dilute solution of ethanoic acid is used as vinegar to flavour food.

3.5 Physics Unit 1 (P1): Force and Motion, Energy, Moments and Radioactivity

Force and Motion

Students investigate the relationship between force and motion. They meet Newton's first and second Laws of Motion and use the mathematical form of the second Law to carry out calculations. They study mass density and weight, kinetic theory, circular motion and momentum.

Content	Learning Outcomes
P1.1 Force and Motion	In the context of how science works, students should be able to: 1.1.1 investigate experimentally the quantitative relationships between average speed, distance and time, including the calculation of average speed from linear distance–time graphs, and use ICT resources to process measurements and analyse data (*w – (i)a, (iii)c*); 1.1.2 distinguish between distance and displacement, speed and velocity; 1.1.3 calculate rate of change of speed (acceleration) as change of speed divided by time taken;
Displacement, Velocity and Acceleration	1.1.4 *recall and use the quantitative relationships between:* - *displacement, time and average velocity; and* - *initial velocity, final velocity, acceleration (retardation) and time* *(problems will only be set on motion in one direction); and*
Displacement–Time Graphs and Velocity–Time Graphs	1.1.5 use graphical methods to determine velocity, acceleration and displacement, applying knowledge that: - the slope of a displacement–time graph is the velocity; - the slope of a velocity–time graph is the acceleration; and - the area under a velocity–time graph is the displacement.

Content	Learning Outcomes
Newton's Laws	In the context of how science works, students should be able to: 1.1.6 recall and understand that forces arise between objects, that the forces on these objects are equal and opposite, and that friction is a force that always opposes motion; 1.1.7 investigate experimentally Newton's first and second Laws, for example using an air track and data logger, or a computer simulation, to study the effect of balanced and unbalanced forces on an object, and through mathematical modelling derive the relationship between resultant force, mass and acceleration (*w – (i)a, (i)b*); 1.1.8 calculate the resultant of two one-dimensional forces; 1.1.9 recall and use the equation: $\text{resultant force} = \text{mass} \times \text{acceleration}$
Mass, Density and Weight	1.1.10 distinguish between the weight and mass of an object, knowing that an object of mass 1 kg has a weight of 10 N, and be able to calculate the weight of an object when given the mass in kilograms using $W = mg$; 1.1.11 investigate experimentally the relationship between the mass and volume of liquids, regular solids and irregular solids, and use ICT to process the data (*w – (i)a, (ii)c*); 1.1.12 analyse and interpret the data gathered in 1.1.11 to derive the relationship between mass and volume (*w – (i)b*); 1.1.13 recall and use the equation $\text{density} = \frac{\text{mass}}{\text{volume}}$ to solve simple problems, and recall and use the units of density g/cm^3 and kg/m^3; and
Kinetic Theory	1.1.14 use the Kinetic Theory to explain qualitatively the changes of state that occur between solids, liquids and gases and relate these to the difference between the densities of solids, liquids and gases (*w – (iii)b*).

Content	Learning Outcomes
Circular Motion	In the context of how science works, students should be able to: 1.1.15 describe some examples of circular motion, explaining how the force acting on an object causes this type of motion; 1.1.16 investigate qualitatively the factors affecting the centripetal force for an object moving in a circle (*w – (i)a, (i)b*); 1.1.17 recall that: - the direction of the centripetal force is towards the centre of the circle; - it increases with the mass and the speed of the object and decreases as the radius of the circle increases; and - if the force is removed, the object will move away at a tangent to the circle; and
Momentum	1.1.18 recall and use the equation momentum = mass × velocity

Energy

Students examine the various forms of energy and the Principle of Conservation of Energy. They study the environmental impact of the use of various energy resources and are introduced to the concept of efficiency. Students also study the concepts of work, kinetic and potential energy.

Content	Learning Outcomes
P1.2 Energy Forms of Energy	In the context of how science works, students should be able to: 1.2.1 investigate, in terms of the Principle of Conservation of Energy, energy transfers involving the following forms of energy: chemical, heat, electrical, sound, light, magnetic, kinetic and potential (gravitational and strain); and 1.2.2 draw and interpret energy transfer diagrams for the investigations carried out in 1.2.1 and appreciate their limitations (*w – (iii)c*).

Content	Learning Outcomes
Energy Resources	In the context of how science works, students should be able to: 1.2.3 describe a range of renewable energy resources, use primary and secondary sources to investigate the effect on the environment of the use of renewable and non-renewable energy resources, and recall their findings (*w – (iv)b*);
Efficiency	1.2.4 recall, understand and use the equation $\text{efficiency} = \dfrac{\text{useful output energy}}{\text{total input energy}}$ 1.2.5 describe and explain various ways of making better use of energy; 1.2.6 review primary and secondary sources relating to the efficiency of domestic appliances (*w – (ii)b*);
Work	1.2.7 recall and use the equation $\text{work} = \text{force} \times \text{distance}$ and that the work done equals the amount of energy transferred;
Power	1.2.8 recall and use the equations $\text{power} = \dfrac{\text{energy transferred}}{\text{time taken}}$ and $\text{power} = \dfrac{\text{work done}}{\text{time taken}}$ to calculate power, work done, time taken or energy transferred; and 1.2.9 plan and carry out experiments to measure personal power and the output power of an electric motor, and evaluate the validity and reliability of their data (*w – (i)a*).

Content	Learning Outcomes
Kinetic and Potential Energy	In the context of how science works, students should be able to: 1.2.10 recall and use the equations $\text{kinetic energy} = \frac{1}{2}\text{mass} \times \text{velocity}^2 \left(\frac{1}{2}mv^2\right)$ $\text{potential energy} = \text{mass} \times \text{acceleration due to gravity} \times \text{height (mgh)}$

Moments

Students meet the concept of centre of gravity and explore its effect on the stability of an object. They examine the Principle of Moments.

Content	Learning Outcomes
P1.3 Moments	In the context of how science works, students should be able to:
Centre of Gravity	1.3.1 recall the meaning of centre of gravity and explain how its position affects the stability of an object;
Moment of a Force	1.3.2 recall and use the equation $\text{moment} = \text{force} \times \text{perpendicular distance from the pivot}$ and understand the implications of this; and
Principle of Moments	1.3.3 plan and carry out experiments to verify the Principle of Moments and use it to calculate the size of a force, or its distance from the pivot, when an object is balanced under the turning effects of no more than two forces, one of which could be the object's weight (*w – (i)a*).

Radioactivity

In this section students study the particle structure of both the atom and the nucleus. They examine radioactivity as a consequence of unstable nuclei and study the properties of alpha, beta and gamma radiation. They are introduced to the terms background activity and half-life and learn about fusion and fission as sources of energy.

Content	Learning Outcomes
P1.4 Radioactivity	In the context of how science works, students should be able to:
Structure of the Atom	1.4.1 research the historical development of the model of atomic structure from the 'plum pudding' model to the present Rutherford–Bohr model (*w – (i)b, (iv)c*);
	1.4.2 describe the structure of atoms in terms of protons, neutrons and electrons;
	1.4.3 recall the relative charge and relative mass of protons, neutrons and electrons;
Structure of the Nucleus	1.4.4 describe a nucleus in terms of atomic number Z and mass number A, using the notation ${}^{A}_{Z}X$ (*w – (iii)c*);
	1.4.5 explain what an isotope is;
Radioactive Decay	1.4.6 recall that some nuclei are unstable and disintegrate emitting alpha, beta or gamma radiation randomly and spontaneously, and that such nuclei are described as radioactive;
	1.4.7 recall that alpha particles are helium nuclei consisting of two protons and two neutrons, beta particles are fast electrons, and gamma radiation is an electromagnetic wave of high energy;
	1.4.8 *describe nuclear disintegrations in terms of equations involving mass numbers and atomic numbers* (*w – (iii)c*); and
	1.4.9 recall, through demonstrations or computer simulations, the range of alpha, beta and gamma radiations, that alpha radiation is stopped by a few centimetres of air or a thin sheet of paper, that beta radiation is stopped by several metres of air or a thin sheet of aluminium, and that gamma radiation easily passes through all of these but can be blocked by lead.

Content	Learning Outcomes
Radioactive Decay (cont.)	In the context of how science works, students should be able to: 1.4.10 know what background activity is, its source and how it is taken into account when measuring activity; 1.4.11 know what ionisation is and recall that radioactive emissions cause dangerous ionisations and the steps taken to minimise the risk to those who use ionising radiations;
Half-Life	1.4.12 through mathematical modelling, based on demonstrations or computer simulations, explain the meaning of the term half-life, carry out simple calculations involving half-life and be able to determine half-life from appropriate graphs;
Nuclear Fission and Fusion	1.4.13 describe nuclear fission in simple terms and be aware that it is a form of energy used in the generation of electricity (fission equations are not required); 1.4.14 know that for fission to occur the uranium 235 or plutonium 239 nucleus must first absorb a neutron and then split into two smaller nuclei and release two or three fission neutrons; 1.4.15 know that the fission neutrons may go on to start a chain reaction; 1.4.16 discuss and debate some of the political, social, environmental and ethical issues relating to the use of nuclear energy to generate electricity (*w – (iv)b*); 1.4.17 describe nuclear fusion in simple terms and be aware that it is the source of a star's energy; 1.4.18 *describe nuclear fusion in terms of an equation involving mass numbers and atomic numbers* (*w – (iii)c*); and 1.4.19 appreciate the potential of nuclear fusion to solve the world's energy needs provided the technological difficulties of fusion reactors can be overcome (*w – (iv)a, (iv)b*).

3.6 Physics Unit 2 (P2): Waves, Sound and Light, Electricity, and the Earth and Universe

Waves, Sound and Light

Students are introduced to the two main categories of waves, as well as the terms used to describe the various properties of waves. They study sound and its applications. They explore the electromagnetic spectrum and examine the use of the various types of electromagnetic wave. Students also study the reflection and refraction of light.

Content	Learning Outcomes
P2.1 Waves, Sound and Light Waves	In the context of how science works, students should be able to: 2.1.1 recall that waves transfer energy from one point to another through vibrations and distinguish between transverse and longitudinal waves in terms of the motion of the particles of the medium, recalling: - sound and ultrasound as examples of longitudinal waves; and - water waves and electromagnetic waves as examples of transverse waves (*w – (iii)a*); 2.1.2 explain the meaning of frequency, wavelength and amplitude of a wave, and recall and use the quantitative relationship $v = f\lambda$ between frequency, wavelength and speed of a wave (*w – (iii)a*); 2.1.3 describe, using simple wavefront diagrams, how plane waves are reflected at plane barriers and refracted at plane boundaries, based on their observations using ripple tanks or computer simulations (*w – (iii)a*); 2.1.4 explore and recall the analogy between the reflection and refraction of water waves and the reflection and refraction of light (see also 2.1.8, 2.1.10 and 2.1.11); 2.1.5 describe some applications of echoes and carry out calculations on the echo principle, to include radar and sonar, and describe some contemporary applications of ultrasound in industry and medicine (*w – (iv)a*);
Electromagnetic Waves	2.1.6 distinguish between the different regions of the electromagnetic spectrum (radio waves, microwaves, infra red, visible light, ultra violet, X-rays and gamma rays) in terms of their wavelength and frequency, and be able to arrange them in order of wavelength and recall that they all travel at the same speed in a vacuum (*w – (iii)a*); and 2.1.7 research the uses and dangers of electromagnetic waves and recall their findings (*w – (iv)a*).

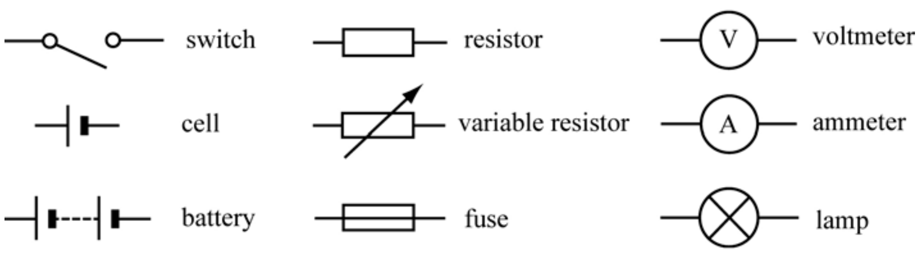
Content	Learning Outcomes
Reflection of Light	In the context of how science works, students should be able to: 2.1.8 investigate how light is reflected by a plane mirror and recall that the angle of incidence equals the angle of reflection, and apply this rule in practical situations (*w – (ii)c*); 2.1.9 investigate through ray tracing the properties of the image seen in a plane mirror and use the properties to solve simple problems (*w – (ii)c*);
Refraction of Light	2.1.10 observe the refraction of light as it passes from air into glass and air into water and vice-versa, and use ray tracing to measure the angles of incidence and refraction (*w – (ii)c*); 2.1.11 recall and understand that when light slows it bends towards the normal and the converse (a knowledge of Snell's Law is not expected) (*w – (iii)a*); and
Dispersion of Light	2.1.12 investigate how light is dispersed by prisms and recall that a spectrum can be produced because different colours of light travel at different speeds in the glass, and the greater the amount of refraction the greater the change of speed (*w – (ii)c*).

Electricity

Students study electrostatics and how it is applied in practical situations. They also investigate electrical circuits and draw them using the correct symbols. They examine series and parallel circuits and investigate the rule for currents and voltages in each type of circuit. They also study the transfer of electrical energy and electricity in the home.

Content	Learning Outcomes
P2.2 Electricity Static Charge	In the context of how science works, students should be able to: 2.2.1 recall that insulating materials can be charged by friction and explain this in terms of transfer of electrons, and understand that positively charged objects have a deficiency of electrons and negatively charged objects have a surplus of electrons (*w – (iii)a*).

Content	Learning Outcomes
Static Charge (cont.)	In the context of how science works, students should be able to: 2.2.2 investigate the forces between charged objects and recall that objects carrying the same type of charge repel each other, while objects carrying different types of charge attract each other, and that a charged object can exert an attractive force on an uncharged object ***and explain the phenomenon*** (*w – (ii)c*); 2.2.3 research the uses and the dangers of electrostatic charge generated in everyday contexts and the precautions that can be taken to ensure that electrostatic charge is discharged safely, and be able to describe their findings (*w – (iv)a*);
Charge Flow	2.2.4 understand the difference between conductors and insulators in terms of free electrons, that an electric current in a metal is a flow of electrons, and that the electrons move in the opposite direction to that of a conventional current (*w – (iii)a*); and 2.2.5 recall and use the quantitative relationship between current, charge and time $\text{current} = \dfrac{\text{charge}}{\text{time}}$ and recall that charge is measured in coulombs (*w – (iii)a*).

Content	Learning Outcomes
Electric Circuits	In the context of how science works, students should be able to: 2.2.6 understand the role of conductors, insulators and switches in simple series and parallel circuits (*w – (iii)a*); 2.2.7 interpret and draw circuit diagrams using the standard symbols illustrated in Fig. 1 (*w – (iii)c*):  Fig. 1 2.2.8 recall the meaning of cell polarity and relate it to the symbol for a cell (*w – (iii)a*);
Resistance, Voltage and Current	2.2.9 understand that the voltage provided by cells connected in series is the sum of the voltages of each cell, having regard to their polarity (*w – (iii)a*); 2.2.10 describe and carry out an experiment to obtain the current–voltage characteristic (I–V graph) for a metal wire at constant temperature; using mathematical modelling, derive the relationship between voltage, current and resistance; recall that this is commonly known as Ohm's Law; and recall and use the equation voltage = current ´ resistance where voltage is measured in volts, current in amperes and resistance in ohms (*w – (ii)c*); 2.2.11 describe and carry out an experiment to obtain the current–voltage characteristic (I–V graph) for a filament lamp, recalling that the resistance of a filament lamp increases as the current through the filament increases (*w – (ii)c*); and 2.2.12 recall that for components connected in series: - the current through each component is the same; and - the voltage of the supply is equal to the sum of the voltages across the separate components (*w – (iii)a*).

Content	Learning Outcomes
Resistance, Voltage and Current (cont.)	In the context of how science works, students should be able to:
	2.2.13 recall that for components connected in parallel: - the voltage across each component is the same as that of the supply; and - the total current taken from the supply is the sum of the currents through the separate components (*w – (iii)a*);
	2.2.14 calculate the total resistance of resistors in series (*w – (iii)a*);
	2.2.15 calculate the resistance of two equal resistors in parallel (*w – (iii)a*);
	2.2.16 *calculate the combined resistance of any number of resistors in parallel* (*w – (iii)a*);
	2.2.17 *calculate the combined resistance of circuits with series and parallel sections* (*w – (iii)a*);
	2.2.18 investigate experimentally how the resistance of a metallic conductor at constant temperature depends on length, *area of cross section and the material it is made from (a knowledge of resistivity is not required)*, and use the findings to solve simple problems (*w – (ii)c*);
Energy and Power	2.2.19 understand why an electrical current flowing through a metal wire generates heat in terms of free electron–atom collisions (*w – (i)c*);
	2.2.20 recall and use the quantitative relationships energy = power ´ time power = current ´ potential difference to calculate power, current and voltage (*w – (iii)a*); and
Electricity in the Home	2.2.21 recall that the unit used in the cost of electricity to the consumer is the kilowatt-hour, and understand the meaning of the kilowatt-hour and use of the power rating of electrical appliances to calculate their cost (*w – (iii)a*).

Content	Learning Outcomes
Electricity in the Home (cont.)	In the context of how science works, students should be able to: 2.2.22 understand one-way and two-way switching (*w – (iii)a*); 2.2.23 recall the wiring inside a fused three-pin plug and understand the function of the live, neutral and earth wires (*w – (iii)a*); 2.2.24 recall that appliances with metal cases are usually earthed and understand how the earth wire and fuse together protect the user from electric shock and the apparatus from potential damage (*w – (iv)a*); 2.2.25 recall the equation $\frac{P}{V} = I$ and use this in calculations to select the appropriate rating of a fuse (*w – (iii)a*); 2.2.26 understand how double insulation protects the user (*w – (iv)a*);
Generation and Transmission of Electricity	2.2.27 describe the difference between a.c. and d.c. and identify sources for each, and recognise the waveforms of a.c. and d.c. supplies from diagrams of cathode ray oscilloscope (CRO) traces (*w – (iii)a*); 2.2.28 investigate electromagnetic induction and understand that a current may be induced in a conductor by its motion relative to a magnet or by changing the current in a neighbouring conductor, and that these effects form the basis of a.c. generators and transformers (*w – (ii)c*); 2.2.29 recall that a.c. generators are used in the generation of electricity and in their simplest form consist of a coil of wire rotated between the poles of a magnet (*w – (iii)a*); 2.2.30 describe the construction of a step-up and a step-down transformer, including the primary coil, secondary coil and core, *and state and use the turns-ratio equation* (*w – (iii)a*) $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ 2.2.31 describe and explain the role of step-up and step-down transformers in the transmission of electricity (*w – (iii)a*).

The Earth and Universe

Students are introduced to the variety of objects that make up our Solar System. They understand how the objects move and the force that keeps them in orbit. The nebular model of the formation of the Solar System is outlined. The Big Bang and supporting evidence are studied. The layered structure of the Earth and the cause of earthquakes and volcanoes are also covered.

Content	Learning Outcomes
P2.3 The Earth and Universe Solar System	In the context of how science works, students should be able to: 2.3.1 describe and explain the nebular model for the formation of the Solar System and recall evidence in support of the model (*w – (i)c*); 2.3.2 describe the main features of the Solar System, including the Sun, the rocky and gas planets, moons, asteroids and comets, ***relating these features to the origin of the Solar System*** (*w – (iii)a*); 2.3.3 recall the order of the eight planets from the Sun outwards (*w – (iii)a*); 2.3.4 recall that gravity provides the centripetal force for the orbital motion of planets, comets, moons and artificial satellites (*w – (iii)a*); 2.3.5 recall, evaluate and discuss the historical evidence for the heliocentric Solar System as opposed to the geocentric, and be aware how acceptance or rejection of each of the two ideas depended on the social and historical context in which it was developed and proposed (*w – (iv)c*); 2.3.6 recall the use of artificial satellites in the observation of the Earth, weather monitoring, astronomy and communications (*w – (iii)a*);
Stars	2.3.7 know that studies of the light from stars, including our Sun, show that they are composed mainly of hydrogen and helium and that their energy is supplied by the fusion of hydrogen into helium, and describe how stars are formed (knowledge of the lifecycle of stars is not required) (*w – (iii)a*); and 2.3.8 ***recall and understand that the stability of stars depends on the balance between gravitational force and gas/radiation pressure*** (*w – (iii)a*).

Content	Learning Outcomes
The Universe	In the context of how science works, students should be able to: 2.3.9 recall that the Universe began as a Big Bang which, according to current measurements, occurred 12–15 billion years ago (*w – (iii)a*); 2.3.10 describe and explain that evidence for the Big Bang includes that light from other galaxies is shifted to the red end of the spectrum, and that this can be explained by space expanding (*w – (i)c*);
Structure of the Earth	2.3.11 recall that the Earth is divided into layers based on mechanical properties and composition (*w – (iii)a*); 2.3.12 recall that the topmost layer is the lithosphere, which is comprised of the crust and the solid portion of the upper mantle (*w – (iii)a*); and 2.3.13 explain the cause of earthquakes and volcanoes (*w – (i)c, (iii)a*).

3.7 Practical Skills Unit

This controlled assessment unit makes up 25 percent of the qualification. The acquisition and development of the skills needed for controlled assessment should form part of normal classroom teaching and learning. They should be an integral part of teachers' schemes of work.

We set six controlled assessment tasks for each cohort of students: two each for biology, chemistry and physics. We renew these tasks each year. Students may attempt two or more tasks, up to a maximum of six. If they attempt more than two tasks, the total of their two highest scoring tasks will be their overall mark for the unit. The two tasks must, however, come from different subject areas within the specification; for example, one biology task and one chemistry task would be allowable, but two physics tasks would not.

Teachers may assess students' performance in the controlled assessment tasks at any time during the course. At the centre's discretion, assessment may occur as part of normal class routine or in a set time block. It is not necessary to assess all students at the same time, even if they are carrying out the same controlled assessment task.

Although teachers can give students feedback on the results of assessments, they should inform the students that their marks may change as a result of moderation.

Each controlled assessment task has three parts:

Part A – Planning and Risk Assessment
Part B – Data Collection
Part C – Processing, Analysis and Evaluation.

Part A - Planning and Risk Assessment

In Part A of the controlled assessment task, students develop a hypothesis and plan an experimental method to investigate that hypothesis. They draw a blank results table to record and process their evidence, and they carry out a risk assessment. Students should complete this part of the task in Candidate Response Booklet A.

Students carry out Part A under a medium (informal) level of control, and teachers assess it using generic marking criteria that we provide (see Section 6). The maximum mark is 18.

Before beginning this part of the controlled assessment task, teachers must refer to the controlled assessment task and our teacher guidance notes.

Content	Learning Outcomes
Planning and Risk Assessment	Students should be able to: · develop a hypothesis that they are going to investigate; · plan a practical experiment to test the hypothesis, including a risk assessment; and · draw a blank results table for recording and processing their data or observations.

Part B - Data Collection

In Part B, students are required to collect data safely while managing any risks they identified in Part A. They record the data in the blank results table they drew in Candidate Response Booklet A.

Because the acquisition and development of the skills that students need for this stage should form part of normal classroom teaching and learning, students taking the controlled assessment task should have had ample opportunity to practise the safe use of scientific techniques for collecting data.

Students carry out this part of the task under a **low (limited)** level of control; there is no assessment.

Content	Learning Outcomes
Data Collection	Students should be able to: · carry out the experimental part of an investigation safely; and · collect sufficient data to complete a blank results table.

Part C - Processing, Analysis and Evaluation

In Part C, students must answer a number of compulsory questions that relate directly to their own work and to secondary data supplied.

The questions appear in **Candidate Response Booklet B**, and students must complete all their answers in this booklet. Extra lined paper and graph paper can be made available on request.

There is a **high (formal)** level of control for this stage of the controlled assessment task: it is assessed. The maximum mark is 27.

Content	Learning Outcomes
Processing, Analysis and Evaluation	Students should be able to: · answer a number of compulsory questions relating directly to their own work and to secondary data supplied; · demonstrate their scientific knowledge and understanding; and · process, analyse and evaluate the work they have completed, the data they recorded in Candidate Response Booklet A, and secondary data supplied.

3.8 Mathematical Content

Students need to be familiar with and competent in the following areas of mathematics in order to develop their skills, knowledge and understanding in Double Award Science.

Students 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; and
- calculate area, perimeters and volumes of simple shapes.

In addition, Higher Tier students 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; and*
- *understand and use percentiles and deciles.*

Students can use calculators in all assessments.

Students are expected to know and use the appropriate units for all the quantities specified. However, they will not necessarily gain credit for the appropriate use of units in assessment questions.

4 Scheme of Assessment

4.1 Assessment opportunities

The availability of examinations and controlled assessment appears in Section 2 of this specification.

Candidates studying unitised GCSE qualifications must complete at least 40 percent of the overall assessment requirements as terminal assessment.

Candidates may resit each individual assessment unit once. If candidates resit a unit, they are free to count the better of the two marks they achieve **unless** the resit makes up part of their 40 percent terminal assessment. If the resit **does** make up part of the terminal assessment, the resit mark will count towards the final grade, even if there is a better score for an earlier attempt.

Please note that for this specification, the Practical Skills unit (controlled assessment) counts towards the 40 percent terminal requirement.

Results for individual assessment units remain available to count towards a GCSE qualification until we withdraw the specification.

4.2 Assessment objectives

Below are the assessment objectives for this specification. Candidates must:

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 Assessment objective weightings

The table below sets out the assessment objective weightings for each examination component and the overall GCSE qualification:

Assessment Component	Nature of Assessment	Assessment Objectives			Component Weighting
		AO1	AO2	AO3	
Unit B1	External	4.4–5.8%	2.6–4.1%	1.8–3.2%	11%
Unit C1	External	4.4–5.8%	2.6–4.1%	1.8–3.2%	11%
Unit P1	External	4.4–5.8%	2.6–4.1%	1.8–3.2%	11%
Unit B2	External	5.6–7.4%	3.4–5.2%	2.2–4.1%	14%
Unit C2	External	5.6–7.4%	3.4–5.2%	2.2–4.1%	14%
Unit P2	External	5.6–7.4%	3.4–5.2%	2.2–4.1%	14%
Practical Skills Unit	Internal Controlled assessment	–	12%	13%	25%
Total		30–39.6%	30–39.9%	25–34.9%	100%

4.4 Quality of written communication

In GCSE Double Award Science, candidates must demonstrate their quality of written communication (QWC). In particular, they must:

- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
- select and use a form and style of writing appropriate to their purpose and to complex subject matter; and
- organise information clearly and coherently, using specialist vocabulary where appropriate.

Examiners and teachers assess the quality of candidates' written communication in their responses to questions or tasks that require extended writing.

4.5 Reporting and grading

We award our GCSE Double Award Science qualification on an eight grade scale from A*A*–GG, with A*A* being the highest. Double intermediate grades such as AB and BC are also awarded. For candidates who fail to attain a grade GG, we report their results as unclassified (UU).

We report the results of individual assessment units on a uniform mark scale that reflects the assessment weighting of each unit. The maximum uniform marks available to candidates entered for the Higher Tier of a unit will be the maximum uniform mark available for that unit. The maximum marks available to candidates entered for the Foundation Tier of a unit will be the maximum uniform mark available for the notional grade C on that unit (the notional grade B minus one uniform mark).

We determine the grades awarded by aggregating the uniform marks obtained on individual assessment units.

The grades we award match the grade descriptions published by the regulatory authorities (see Section 5).

Unit results

Units B1, C1 and P1

For each of the units B1, C1 and P1, there are 70 raw marks available at Foundation Tier and 70 at Higher Tier.

The **maximum** uniform mark for each unit is 66. The **minimum** uniform mark required for each grade is as follows:

A*	A	B	C	D	E	F	G
59	53	46	40	33	26	20	13

Candidates entering for Foundation Tier can achieve a maximum uniform mark score of 45 in each Unit 1.

Units B2, C2 and P2

For each of the units B2, C2 and P2, there are 90 raw marks available at Foundation Tier and 90 at Higher Tier.

The **maximum** uniform mark for each of the Units B2, C2 and P2 is 84. The **minimum** uniform mark required for each grade is as follows:

A*	A	B	C	D	E	F	G
76	67	59	50	42	34	25	17

Candidates entering for Foundation Tier can achieve a maximum uniform mark score of 58 in each Unit 2.

Practical Skills Unit (Controlled assessment)

The **maximum** uniform mark for the Practical Skills Unit is 150. The **minimum** uniform mark required for each grade is as follows:

A*	A	B	C	D	E	F	G
135	120	105	90	75	60	45	30

Qualification results

The maximum uniform mark for the final award is 600. The minimum uniform mark required for each grade is as follows:

A*A*	A*A	AA	AB	BB	BC	CC	CD
540	510	480	450	420	390	360	330

DD	DE	EE	EF	FF	FG	GG
300	270	240	210	180	150	120

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 depends 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 performances in others.

Grade	Description
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 judgements consistently and draw detailed, evidence-based conclusions.

Grade	Description
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.
F	Candidates recall, select and communicate their limited knowledge and understanding of science. They recognise simple inter-relationships between science and society. They have a limited understanding that advances in science may have ethical implications, benefits and risks. 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.

6 Guidance on Controlled Assessment

6.1 Controlled assessment review

We replace our controlled assessment tasks every year to ensure that they continue to set appropriate challenges and at the same time remain valid, relevant and stimulating to encourage candidates to achieve their true potential.

6.2 Skills assessed by controlled assessment

The controlled assessment tasks draw on candidates' ability to:

- develop hypotheses and plan practical ways to test them, including risk assessment;
- collect data while managing any associated risks;
- process, analyse and interpret primary and secondary data;
- draw evidence-based conclusions;
- review and evaluate methods of data collection and the quality of the resulting data; and
- review hypotheses in light of outcomes.

6.3 Levels of control

The rules for controlled assessment in GCSE Sciences are defined for the three stages of the assessment:

- Task setting;
- Task taking; and
- Task marking.

The purpose of the controls is to ensure the validity and reliability of the assessment and to enable teachers to confidently authenticate candidates' work.

6.4 Task setting

The level of control for task setting is high. We set six comparable tasks for each cohort of students. We renew these each year. Candidates may sit two or more of the controlled assessment tasks, up to a maximum of six. However, they cannot take a specific task more than once.

We supply the controlled assessment tasks, along with teacher guidance notes, in September each year. Centres must keep these in a secure place, for example a locked metal filing cabinet. Even when candidates' work is under way, they must not be allowed to take their Candidate Response Booklets with them after class; these must be stored securely at all times.

A centre may choose to contextualise the task that we have set if, for example, the centre lacks availability and access to the resources required. However, this must not change the nature of the task; all candidates must carry out the task that we have set.

6.5 Task taking

Part A – Planning and Risk Assessment

This part of the controlled assessment task is carried out under a medium (informal) level of control. Teachers assess it using marking criteria that we provide.

Area of Control	Detail of Control
Authenticity	Candidates must complete their Planning and Risk Assessment under medium (informal) supervision. They must complete all work that is to be submitted in Candidate Response Booklet A. They must not remove work that they have completed in Candidate Response Booklet A from the classroom. If a candidate fails to complete all sections of the booklet in one sitting, the teacher should collect the work, store it in a secure place and return it to the candidate at the beginning of the next session.
Feedback	Teachers may discuss aspects of the task in general terms with the candidates. This discussion should not be too specific, as candidates must make their own planning decisions. Teachers may also discuss with candidates, in general terms, the skills required to reach maximum marks in each of the bands in the generic mark schemes for planning and risk assessment. Candidates may also carry out a trial of their proposed method using any apparatus they might need.
Time Limit	There is no time limit for the planning and risk assessment phase of the task.
Collaboration	Before documenting their planning and risk assessment activities in Candidate Response Booklet A, candidates may discuss aspects of the task as a class and/or in small groups (of up to three). Candidates can also carry out trials with any apparatus/ equipment individually or in small groups of up to three. However, when completing their work in Candidate Response Booklet A, candidates must work individually. It is the responsibility of the teacher to ensure that any assessable outcomes can be attributed to individual candidates.

Area of Control	Detail of Control
Resources	When carrying out a trial of their investigation, candidates may have access to any practical apparatus/equipment available to the centre. Teachers must guide and supervise them to ensure that they comply with the necessary health and safety requirements. Candidates may have access to their notes, textbooks and the internet during the planning and risk assessment stage of the task. As QWC is assessed in this part of the controlled assessment task, they are not allowed access to dictionaries, spell checks and grammar facilities. This includes online or electronic versions.

Part B – Data Collection

There is a low (limited) level of control for this stage of the controlled assessment task; it is not assessed.

Area of Control	Detail of Control
Authenticity	Candidates must complete this stage of the controlled assessment task under limited supervision. Teachers must supervise to ensure that candidates comply with the necessary health and safety requirements.
Feedback	Significant teacher guidance is permitted during the data collection stage: teachers can give help to candidates just as they would during any teaching and learning situation. However, they must avoid giving answers to questions that appear in the assessed Processing, Analysis and Evaluation stage of the assessment (Part C).
Time Limit	There is no time limit for the data collection part of the assessment.
Collaboration	As the work of individual candidates can be informed by working with others, candidates may carry out their data collection either individually or in small groups of up to three (ideally groups of two). It is a requirement that each individual candidate makes an active contribution to carrying out the experiment and collecting data. If one candidate in a group refuses to participate in the data collection process, that candidate should not be permitted to take the assessed Part C of the task.

Area of Control	Detail of Control
Resources	Candidates must have access to their Candidate Response Booklet A containing: · their plan and risk assessment; and · the blank results table they need to record their data. Candidates may have access to any practical apparatus/ equipment available to the centre. Teachers must supervise them to ensure that they comply with the necessary health and safety requirements.

Part C – Processing, Analysis and Evaluation

There is a high (formal) level of control for this stage of the controlled assessment task.

Area of Control	Detail of Control
Authenticity	This stage of the controlled assessment task must take place under formal supervision. Candidates must complete all work under the direct supervision of a teacher. All work must be completed in Candidate Response Booklet B.
Feedback	Teachers must not give any assistance during this stage.
Time Limit	The maximum time allowed for the completion of Part C is 1 hour, and candidates must complete it in one sitting.
Collaboration	Candidates must work independently. They must not communicate with each other during this phase.
Resources	Candidates must have access to the work they completed in their Candidate Response Booklet A. They must not use other pre-prepared materials or have access to the internet, email or portable memory devices. They may, however, use calculators.

6.6 Task marking

The level of control for task marking is medium.

A candidate's final mark must be based on two controlled assessment tasks. If a candidate has attempted more than two of the tasks we set, their overall mark for the unit is the sum of the marks they achieved in the two highest scoring tasks.

Candidates must not attempt a controlled assessment task more than once.

Part A - Planning and Risk Assessment

Teachers mark the candidates' planning and risk assessment work using the generic marking criteria shown in this section.

They must view the planning and risk assessment work submitted in Candidate Response Booklet A as candidates' final piece of work and mark it accordingly. **Teachers must not return this work to candidates for redrafting.**

Generic Marking Criteria for Part A: Planning

Band	Descriptor	Increasing complexity of method
(0 marks)	A mark of zero must be awarded for work not worthy of credit.	↓
Band 1 (1–4 marks)	Making little or no use of appropriate specialist terms, candidates state simply what they hope to find out in the investigation. They develop a simple plan to collect and record a limited amount of appropriate evidence. They identify a key factor to vary and select suitable equipment/apparatus. They identify an area in the investigation that could reduce the reliability of the data/evidence collected. The form, style, spelling, grammar and punctuation are of a limited standard.	
Band 2 (5–8 marks)	Using some appropriate specialist terms, candidates develop a hypothesis, with scientific reasoning, as to the outcomes of the investigation. They develop a plan, with some degree of complexity, to collect and record a significant amount of appropriate evidence. They identify key factors to investigate and measure/observe and select suitable equipment/apparatus. They identify areas in the investigation that could affect the reliability of the data/evidence collected and explain the steps taken to ensure its reliability. The form, style, spelling, grammar and punctuation are of a satisfactory standard.	
Band 3 (9–12 marks)	Using appropriate specialist terms throughout, candidates develop a hypothesis, with detailed scientific reasoning, as to the outcomes of the investigation. They develop a complex plan to collect and record a wide range of appropriate evidence. They identify key factors to investigate, measure/observe and control and select suitable equipment/apparatus. They discuss in detail areas of the investigation that could affect the reliability of the data/evidence collected and the steps taken to ensure its reliability. They explain their strategies to deal with anomalous results/ observations. The form, style, spelling, grammar and punctuation are of a high standard.	

Generic Marking Criteria for Part A: Risk Assessment

Band	Descriptor
(0 marks)	A mark of zero must be awarded for work not worthy of credit.
Band 1 (1–2 marks)	Candidates state a safety hazard specific to the investigation and state briefly the hazardous outcomes that may result.
Band 2 (3–4 marks)	Candidates identify some of the safety hazards specific to the chosen investigation and explain the hazardous outcomes. They state the steps needed to minimise these risks.
Band 3 (5–6 marks)	Candidates identify all the safety hazards specific to the chosen investigation and explain in detail both the hazardous outcomes and the steps needed to minimise these risks.

It is up to the professional judgement of the teacher to decide which mark descriptors best apply and hence what mark to award for a particular skill.

Teachers should award zero marks only in the unlikely event of a candidate's work not being worthy of any credit.

Teachers should lightly annotate candidates' work to assist moderation. The annotation should be brief but must highlight any aspects of the work that meet the key requirements of a particular mark band.

After marking the candidates' planning and risk assessment work, the teacher has three options to allow the candidate to move forward in the investigation:

Scenario	Action by Teacher
1 The candidate's plan and risk assessment are deemed to be appropriate.	Instruct the candidate to use their proposed plan and risk assessment to collect the required data/evidence.
2 The candidate's plan and risk assessment are, with some minor amendment suggested by the teacher, deemed to be appropriate.	Amend the candidate's plan and risk assessment, and return it to the candidate. Relay any amendments to them both verbally and in writing. Then instruct the candidate to collect the required data/evidence using the amended plan and risk assessment.
3 The candidate's plan and risk assessment are deemed to be unsuitable and inappropriate.	Give an alternative plan and risk assessment to the candidate, and instruct them to collect the required data/evidence using this teacher's plan.

Teachers must ensure that the work they are marking is the candidate's own. They must sign a declaration on their Candidate Response Booklet A certifying that all of the work the candidate has submitted for assessment is their own and has been done in accordance with our controlled assessment regulations. Candidates must also sign the front of their Candidate Response Booklet A.

Part C – Processing, Analysis and Evaluation

Teachers mark candidates' work in Part C, adhering closely to the marking guidelines that we supply. They should use red ink to place marks in the right-hand margin of each Candidate Response Booklet B, then transfer the total for each question to the front cover.

Teacher judgement is sometimes necessary to determine if a candidate deserves a mark. If at a particular point it is not clear why they have awarded a mark, they should add a brief note to explain. This will show the external moderator why the teacher felt the candidate had earned the mark.

Teachers must ensure that the work they are marking is the candidate's own. They must sign a declaration on the Candidate Response Booklet B certifying that all of the work the candidate has submitted for assessment is their own and has been done in accordance with our controlled assessment regulations. Candidates must also sign the front of the Candidate Response Booklet B.

For up-to-date advice on plagiarism or any other incident in which candidate malpractice is suspected, please refer to the Joint Council for Qualifications' *Suspected Malpractice in Examinations and Assessments: Policies and Procedures* on the JCQ website at www.jcq.org.uk

Recording assessment

Centres should complete the Candidate Record Sheet (CRS) for each candidate, including:

- the titles of the two controlled assessment tasks;
- a short description of the method used in each task; and
- the overall marks for the two highest scoring controlled assessment tasks for that candidate.

The teacher and candidate declaration on each form must be signed.

Agreement trials and support

We conduct agreement trials each year, where we brief teachers on how to apply the marking guidelines and they engage in trial marking.

We also issue supplementary training materials to all centres in the form of advice on assessment and exemplar materials.

6.7 Internal standardisation

Centres in which two or more teachers are involved in the marking process must conduct internal standardisation to ensure they apply the marking guidelines consistently. They should select the work of several candidates across teaching groups. Teachers should mark each candidate's work independently, then use the marking guidelines provided to reach agreement on the marks to award. Centres must complete the appropriate documentation (TAC2 form) to confirm that internal standardisation has taken place. The Head of Department must sign the TAC2 form.

6.8 Moderation

Centres must submit their marks and samples to us by May in any year. We may adjust centres' marking. This is to bring the assessment of the candidates' work into line with our agreed standards.

We issue full instructions well in advance of submission on:

- the details of moderation procedures;
- the nature of sampling; and
- the dates by which centres have to submit marks and samples to us.

For each candidate we randomly select for moderation, centres must submit the following documentation:

- the candidate's completed Candidate Response Booklets, A and B, for each task (both booklets must be dated and signed by both the teacher and the candidate); and
- the CCEA Candidate Record Sheet (attached to the candidate's work).

We issue blank copies of all of the above documents, along with the controlled assessment tasks and guidance notes for teachers, in September each year.

Teachers and centre staff may contact us at any stage if they require advice, assistance or support regarding any aspect of controlled assessment.

7 Links

7.1 Support

We provide the following resources to support this specification:

- our website;
- a subject microsite within our website;
- specimen papers and mark schemes; and
- specimen controlled assessment tasks.

Some support material from the previous specification may also remain useful.

We intend to expand our range of support to include the following:

- past papers;
- mark schemes;
- Chief Examiner's reports;
- Principal Moderator's reports;
- schemes of work;
- Topic Tracker*;
- controlled assessment guidance for teachers;
- student guides;
- centre support visits;
- support days for teachers;
- agreement trials; and
- exemplification of examination performance.

* Topic Tracker allows teachers to produce their own test papers using past paper examination questions, and a mark scheme is generated to match.

You can find our annual support programme of events and materials for Double Award Science on our website at www.ccea.org.uk

7.2 Curriculum objectives

This specification addresses and builds upon the broad curriculum objectives for Northern Ireland and Wales. It should help to facilitate the study of science, physics, chemistry, biology and related subjects at a more advanced level.

The study of Double Award Science can contribute to an understanding of spiritual, moral, ethical, social and cultural issues by promoting an awareness that the practice of science is a cooperative and cumulative activity and that it is subject to social, economic, technological, ethical and cultural influences and limitations. It can also contribute to an awareness of environmental issues, promoting an understanding that the application of science may be both beneficial and detrimental to the individual, the community and the environment.

A course based on this specification should give students opportunities to:

- acquire a systematic body of scientific knowledge and the skills needed to apply it in new and changing situations in a range of domestic, industrial and environmental contexts;
- acquire an understanding of scientific ideas, how they develop, the factors that may affect their development and their power and limitations;
- evaluate (in terms of their scientific knowledge and understanding) the benefits and drawbacks of scientific and technological developments (including those related to the environment, personal health and quality of life) and consider ethical issues, where appropriate;
- select, organise and present information clearly and logically, using appropriate scientific terms and conventions, and using ICT where appropriate;
- further develop the following Cross-Curricular skills:
  - Communication;
  - Using Mathematics; and
  - Using ICT;
- enhance their Thinking Skills and Personal Capabilities, including:
  - managing information, self-management, problem-solving and decision-making through the study of subject content; and
  - being creative and working with others through practical opportunities;
- further develop the knowledge, understanding and skills of the Key Stage 3 science curriculum;
- develop an awareness of the role of science in society, its potential and limitations, and develop STEM-related skills;
- critically evaluate scientific information, be aware of some current ethical considerations, and make informed decisions that affect health and well-being of self and the environment; and
- increase their scientific literacy in general.

7.3 Key Skills

This specification provides opportunities for students to develop and generate evidence for assessing the following nationally recognised Key Skills:

- Application of Number
- Communication
- Improving Own Learning and Performance
- Information and Communication Technology
- Problem-Solving
- Working with Others.

You can find details of the current standards and guidance for each of these skills on the CCEA website at www.ccea.org.uk

7.4 Examination entries

Entry codes for this subject and details on how to make entries are available on our Qualifications Administration Handbook microsite, which you can access at www.ccea.org.uk

Alternatively, you can telephone our Examination Entries, Results and Certification team using the contact details provided in this section.

7.5 Equality and inclusion

We have considered the requirements of equalities legislation in developing this specification.

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

The revised GCSE and qualification criteria were reviewed to identify whether any of the competences required by the subject presented a potential barrier to any students with disabilities. 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 and equality groups and with people with disabilities.

During the development process, we carried out an equality impact assessment. This was to ensure that we identified any additional potential barriers to equality and inclusion. Where appropriate, we have given consideration to measures to support access and mitigate against barriers.

Reasonable adjustments are made for students with disabilities in order to reduce barriers to accessing assessments. For this reason, very few students will have a complete barrier to any part of the assessment. Students with physical impairment may instruct a practical assistant to set up equipment but may have difficulty in making observations and in manipulating the equipment to carry out the experiment.

Students with a visual impairment may find elements of the assessment difficult, but technology may help visually impaired students to take readings and make observations. Therefore the assessments should not pose a difficulty for these learners.

It is important to note that where access arrangements are permitted, they must not be used in any way that undermines the integrity of the assessment. You can find information on reasonable adjustments in the Joint Council for Qualifications' document *Access Arrangements and Special Consideration: Regulations and Guidance Relating to Candidates Who Are Eligible for Adjustments in Examinations.*

7.6 Contact details

The following list provides contact details for relevant staff members and departments:

- Specification Support Officer: Nuala Braniff
  (telephone: (028) 9026 1200, extension 2292, email: nbraniff@ccea.org.uk)

- Officer with Subject Responsibility: Kevin Henderson
  (telephone: (028) 9026 1200, email: khenderson@ccea.org.uk)

- Examination Entries, Results and Certification
  (telephone: (028) 9026 1262, email: entriesandresults@ccea.org.uk)

- Examiner Recruitment
  (telephone: (028) 9026 1243, email: appointments@ccea.org.uk)

- Distribution (past papers and support materials)
  (telephone: (028) 9026 1242, email: cceadistribution@ccea.org.uk)

- Support Events Administration
  (telephone: (028) 9026 1401, email: events@ccea.org.uk)

- Information Section (including Freedom of Information requests)
  (telephone: (028) 9026 1200, email: info@ccea.org.uk)

- Business Assurance (appeals)
  (telephone: (028) 9026 1244, email: appealsmanager@ccea.org.uk).

Appendix 1

Glossary of Terms for Controlled Assessment Regulations

Term	Definition
Component	A discrete, assessable element within a controlled assessment/qualification that is not itself formally reported and for which the awarding body records the marks May contain one or more tasks
Controlled assessment	A form of internal assessment where the control levels are set for each stage of the assessment process: task setting, task taking, and task marking
External assessment	A form of independent assessment in which question papers, assignments and tasks are set by the awarding body, taken under specified conditions (including detailed supervision and duration) and marked by the awarding body
Formal supervision (High level of control)	The candidate must be in direct sight of the supervisor at all times. Use of resources and interaction with other candidates is tightly prescribed.
Informal supervision (Medium level of control)	Questions/tasks are outlined, the use of resources is not tightly prescribed and assessable outcomes may be informed by group work. Supervision is confined to: · ensuring that the contributions of individual candidates are recorded accurately; and · ensuring that plagiarism does not take place. The supervisor may provide limited guidance to candidates.
Limited supervision (Low level of control)	Requirements are clearly specified, but some work may be completed without direct supervision and will not contribute directly to assessable outcomes.

Term	Definition
Mark scheme	A scheme detailing how credit is to be awarded in relation to a particular unit, component or task Normally characterises acceptable answers or levels of response to questions/tasks or parts of questions/tasks and identifies the amount of credit each attracts May also include information about unacceptable answers
Task	A discrete element of external or controlled assessment that may include examinations, assignments, practical activities and projects
Task marking	Specifies the way in which credit is awarded for candidates' outcomes Involves the use of mark schemes and/or marking criteria produced by the awarding body
Task setting	The specification of the assessment requirements Tasks may be set by awarding bodies and/or teachers, as defined by subject-specific regulations. Teacher-set tasks must be developed in line with awarding body specified requirements.
Task taking	The conditions for candidate support and supervision, and the authentication of candidates' work Task taking may involve different parameters from those used in traditional written examinations. For example, candidates may be allowed supervised access to sources such as the internet.
Unit	The smallest part of a qualification that is formally reported and can be separately certificated May comprise separately assessed components

Revision History Number	Date of Change	Page Number	Change Made
Version 2	31 August 2011	49	Spelling correction in content section.
Version 2	31 August 2011	79	Deletion and addition of words in descriptor section.
Version 3	5 July 2012	19	Text added.
Version 3	5 July 2012	27	Deletion of paragraph 1.1.1 and addition of new paragraph 1.1.1.
Version 3	5 July 2012	Throughout document	Removal of references to England
Version 4	7 June 2013	18	Text edited in 2.2.3