OCR
RECOGNISING ACHIEVEMENT

AS/A Level GCE

GCE Science

OCR Advanced Subsidiary GCE in Science H178

specification

version 3 – September 2013

QAN 500/2212/X

Contents

Vertical black lines indicate a significant change to the previous printed version.

1 About these Qualifications

This booklet contains OCR's Advanced Subsidiary GCE specification in science for teaching from September 2013.

The OCR AS GCE Science specification extends GCSE science and contains elements of biology, chemistry and physics, as well as earth science and environmental science. The specification is purpose-built for those candidates who wish to continue with a broad study of science beyond GCSE, but who choose not to specialise in the separate science disciplines. All units draw, as appropriate, on the content identified in the QCA Subject Criteria for Biology, Chemistry and Physics. The content is chosen to provide a balanced and coherent study of science. To this end, content from earth science and environmental science is also included.

1.1 The Three-Unit AS

The AS GCE is a 'stand-alone' qualification.

From September 2013 the AS GCE is made up of **three** mandatory units, of which **two** are externally assessed and **one** is internally assessed.

1.2 Qualification Titles and Levels

This qualification is shown on a certificate as:

- OCR Advanced Subsidiary GCE in Science.

This qualification is Level 3 in the National Qualification Framework (NQF).

1.3 Aims

The aims of this specification are to encourage candidates to:

- develop their interest in and enthusiasm for science, including developing an interest in further study and careers in science;
- appreciate how society makes decisions about scientific issues and how the sciences contribute to the success of the economy and society;

- develop and demonstrate a deeper appreciation of the skills, knowledge and understanding of *How Science Works*;

- develop essential knowledge and understanding of different areas of science and how they relate to each other.

1.4 Prior Learning/Attainment

This specification has been developed for students who wish to continue with a study of science at Level 3 in the National Qualifications Framework (NQF). This AS specification has been written to provide progression from GCSE Science and GCSE Additional Science, or from the separate sciences at GCSE; achievement at a minimum of grade C in these qualifications should be seen as the normal requisite for entry to AS Science. However, students who have successfully taken other Level 2 qualifications in science or applied science are also likely to have acquired sufficient knowledge and understanding to begin the course. Other students without formal qualifications may have acquired sufficient knowledge and understanding of science to enable progression onto the course.

Recommended prior learning for the AS units is shown in the introduction to each AS unit.

2 Summary of Content

Each unit is divided into a number of teaching modules. Within each module, the content is divided into two columns: **context and exemplification** and **assessable learning outcomes**. Only the statements in the right-hand column will be examined; statements in the left-hand column are included to provide guidance on delivery. References to HSW (How Science Works) are to Appendix B.

2.1 AS Units

Unit G641: *Remote Sensing and the Natural Environment*

- sensing the environment using electromagnetic radiation;
- stable and vulnerable ecosystems.

Unit G642: *Science and Human Activity*

- weather, climate and climate change;
- chemical processes in the atmosphere;
- proteins and genetic engineering;
- options for energy generation.

Unit G643: *Practical Skills in Science*

- case study;
- practical task.

3 Unit Content

3.1 AS Unit G641: *Remote Sensing and the Natural Environment*

This unit consists of **two** teaching modules.

Module 1. **Sensing the environment using electromagnetic radiation:**

1.1.1 emission and detection of visible and non-visible radiation; the electromagnetic spectrum;
1.1.2 interpreting space and satellite images.

Module 2. **Stable and vulnerable ecosystems**:

1.2.1 energy balances and flows in cells and ecosystems;

1.2.2 nutrient cycles in ecosystems and agriculture;

1.2.3 biodiversity and ecosystems.

Candidates are expected to apply knowledge, understanding and other skills gained in this unit to new situations and/or to solve related problems.

Recommended Prior Knowledge

Candidates should:

- have achieved Grade C or above in both GCSE Science and GCSE Additional Science, or an equivalent standard in other appropriate Level 2 qualifications.

Links

3.7 GCSE Science

(i) Organisms and health:
(a) organisms are interdependent and adapted to their environments;
(b) variation within species can lead to evolutionary changes and similarities and differences between species can be measured and classified;
(c) the ways in which organisms function are related to the genes in their cells;
(d) chemical and electrical signals enable body systems to respond to internal and external changes, in order to maintain the body in an optimal state.

(ii) Energy, electricity and radiations:

(c) radiations, including ionising radiations, can transfer energy;
(d) radiations in the form of waves can be used for communication.

3.9 GCSE Additional Science

(i) Biology:

(a) cells and growth. Chemical reactions essential for life and growth take place inside cells. Differences between plant and animal cells lead to different patterns of growth and development;

(b) plant biomass provides energy and nutrients for other organisms. Through the consumption of organisms and decay, energy flows through the biosphere and chemical elements are recycled within it.

G641 Module 1: 1.1 Sensing the Environment using Electromagnetic Radiation

Remote sensing provides information about the environment to scientists. The interpretation of satellite images and other remotely sensed data is contrasted with the way the human visual system operates. The wave model of electromagnetic radiation is studied in order to understand these applications of sensing.

The following aspects of How Science Works may be assessed during this module:

1. Use theories, models and ideas to develop and modify scientific explanations.
2. Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas.
4. Communicate information and ideas in appropriate ways using appropriate terminology.
5. Analyse and interpret data to provide evidence and recognise correlations and causal relationships.

Links

AS Unit G641 Module 2: Absorption of light by chlorophyll

AS Unit G642 Module 4: Epidemiology

Context and exemplification	Assessable learning outcomes
1.1.1 Emission and detection of visible and non-visible radiation; the electromagnetic spectrum:	Candidates should be able to:
• for example, observations of water surface waves showing reflection and refraction at plane interfaces, obstacles and gaps in barriers;	*The wave behaviour of light* (a) describe and explain features of wave behaviour: • diffraction; • reflection; • refraction;
• the dependence of diffraction phenomena on the relative sizes of wavelength and of obstacles and gaps;	(b) use wave and ray diagrams to show the behaviour of light during diffraction, reflection and refraction;

- comparison of the usefulness of wave and ray representations;
- use of prisms and diffraction gratings to obtain white light spectra;
- comparison of the health hazards of different types of radiation (links to work on epidemiology in Module 2.4.2);
- classification of examples of human applications of electromagnetic radiation as involving either energy transfer or information transfer;
- details of digital sampling and analogue modulation methods are not required. Visual signalling includes system-to-system (such as in barcode readers) and system-to-human (as in interpretation of visual symbols).

(c) describe evidence for the wave nature of light;

Wavelength, colour and the electromagnetic spectrum

(d) recall that white light is composed of a range of wavelengths of radiation;

(e) describe the nature of the receptor cells in the eye:
- rods and cones;
- the different response curves of the cone cells;
- the perception of colour produced by the signals from these cells;

(f) describe evidence for a simple wave model of electromagnetic radiation;

(g) explain and use the terms:
- wavelength;
- frequency;
- speed;

(h) apply the equation $c = f\lambda$ to any part of the electromagnetic spectrum using standard form to express values;

Transmission, absorption and energy transfer

(i) describe examples of the transfer of energy by electromagnetic radiation from a source to an absorber:
- energy transfer from the Sun, through the vacuum of space;
- absorption by pigments such as chlorophyll;
- the use of radiant heaters;
- emission and absorption by the human body;

(j) describe how light received by eyes and cameras is affected by reflection, refraction, diffraction and scattering, and the consequences for the resulting image;

(k) assess the effect of these processes on the interpretation of the received image;

Applications of electromagnetic radiation: energy and information transfer

(l) compare the ways in which different types of electromagnetic radiation may interact with the human body:
- gamma rays and X-rays (causing cell

damage by ionisation);

- ultraviolet (absorption by the skin and resultant cell damage);
- visible (sensed by the eye);
- infrared (warming effect);
- microwave and radio waves (low energy density so not sensed);

(m) describe examples of the use of electromagnetic radiation to transfer information:

- digital and analogue radio signals for broadcasting;
- microwave signals for mobile phones;
- infrared remote control devices;
- visual signalling;
- ultraviolet signals in optical fibres.

1.1.2 Interpreting space and satellite images:	Candidates should be able to:
• comparison of resolutions of digital images and of digital cameras.	(a) interpret grey-scale images of the Earth and other objects in space made using electromagnetic radiation: • visible light; • near infrared; • thermal infrared; • radar; (b) explain how the appearance of the image is used to make deductions about it, including: • the temperature of the object (for thermal infrared images); • the presence of water or vegetation (in near-infrared images); • the size of objects in the image (radar); (c) interpret false colour images displaying information about three separate wavelength ranges, given suitable data; (d) describe some of the factors which can limit the interpretation and resolution of remotely sensed images: • absorption in the atmosphere; • scattering in the atmosphere; • diffraction; • pixel density; (e) interpret data on the sensitivities (frequency ranges, intensity ranges) of different detectors to electromagnetic radiation: • the human eye; • photographic film; • charge-coupled devices.

Practical Skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments:

- use ripple tanks to investigate wave phenomena;
- carry out experiments using infrared sensors to show the effect of vegetation and wet soil on near infrared;
- the use of temperature probes to investigate the reflectance and absorbance of thermal infrared from different surfaces.

G641 Module 2: 1.2 Stable and Vulnerable Ecosystems

Energy flows and nutrient cycles take place in all ecosystems. These processes are contrasted with the transfer of energy and nutrients on a cellular level.

Some examples are given of the effect of human exploitation on ecosystems.

Links

AS Unit G641 Module 1: *Absorption of light by pigments*

Context and exemplification	Assessable learning outcomes
1.2.1 Energy balances and flows in cells and ecosystems: • identification of autotrophs in a wide variety of ecosystems, including extreme environments such as close to underwater volcanoes.	Candidates should be able to: *Cells* (a) describe the role of key organelles in a eukaryotic cell, relevant to the processes of energy transfer: • plasma (cell) membrane; • mitochondria; • choroplasts (in plant cells); • cytoplasm; *Photosynthesis* (b) describe the process of photosynthesis: • absorption of light from the Sun by chlorophyll; • the conversion of water into hydrogen atoms, oxygen and ATP in a light-dependent stage; • the conversion of carbon dioxide into glucose in a light-independent stage • the transfer of energy into a stored form; (c) interpret data and energy flow diagrams relating to photosynthesis, using these concepts: • energy transfer; • conservation of energy; • energy storage and energy dissipation; (d) explain the term autotroph and describe examples of: • photosynthesising organisms; • organisms that use chemical reactions as primary energy sources;

	Respiration (e) explain that living things transfer energy for: • biosynthesis (including proteins); • movement; • active transport of materials across cell membranes; (f) describe the processes involved in passive and active transport across a cell membrane: • diffusion down a concentration gradient; • the role of carrier proteins and protein channels; • active transport against a concentration gradient and the requirement for energy transfer; (g) describe the process of respiration: • the sites of respiration (mitochondria or cytoplasm); • the breakdown of glucose and the formation of ATP; • the role of ATP molecules as mobile energy stores;
• no biochemical details will need to be recalled; candidates may be asked, for example, to calculate the number of molecules of ATP which could be produced during respiration, given suitable data.	(h) compare the processes of aerobic and anaerobic respiration: • the different conditions; • differences in the number of molecules of ATP produced; • differences in the end products of the two processes; (i) interpret data and energy flow diagrams for energy transfer processes at the cellular level, showing understanding of: • energy storage; • conservation of energy; • dissipation of energy; *Energy transfer in ecosystems* (j) explain and use the terms: productivity, food chain, food web, trophic level, producer, consumer, decomposer; (k) perform calculations, given suitable data, which estimate energy transfer values in an ecosystem.

1.2.2 Nutrient cycles in ecosystems and agriculture:

- for example, candidates may be asked to interpret data relating to the productivity of inorganic and organic farming;
- the candidates may evaluate the arguments for industrial fixing as human population rises;

- the history of the development of the Haber process and its exploitation in food production provide rich themes for discussion of the ethics of the applications of science.

Candidates should be able to:

The nitrogen cycle

(a) describe the nitrogen cycle, including:
  - inputs such as biological and atmospheric fixing, human waste;
  - outputs such as leaching and harvesting;
  - decomposer action and denitrification;
  - uptake through the roots of plants;

(b) identify fluxes and reservoirs in a nutrient cycle;

(c) explain the limitations on an ecosystem resulting from limitations in the rate of nitrogen fixing;

(d) give examples of other nutrient elements and their roles in plant growth;

(e) describe the action of decomposer organisms (bacteria and fungi) in maintaining nutrient levels in soil;

(f) interpret data on experimental investigation of soil mineral content and plant growth;

(g) use and explain the terms *negative feedback* and *steady state* in the context of nutrient levels in soils;

(h) contrast the terms *negative feedback* and *positive feedback*:
  - give an example of a naturally occurring positive feedback loop;
  - explain why positive feedback is rarely observed in biological systems;

(i) interpret data on nutrient inputs and outputs:
  - analyse whether an ecosystem is in steady state;
  - calculate values for input, output or fluxes within the cycle;

Human influences

(j) describe industrial nitrogen fixing (the Haber process):
  - write a word equation for the Haber process;
  - describe the conditions of pressure, temperature and catalyst required;
  - state that the ammonia may be further converted into nitrates;

(k) interpret data on the nitrate content of human water supplies and the possible health impacts;

(l) describe the process of eutrophication as an example of disruption of nutrient cycling by human activity;

(m) explain the impact of eutrophication on ecosystem biodiversity.

1.2.3 Biodiversity and ecosystems:

Candidates should be able to:

Ecosystem principles

(a) use the terms *biome*, *ecosystem*, *community*, *population* and *habitat*;

(b) explain how the productivity of an ecosystem may be measured:

- the use of biomass as a measure;
- the use of the units kJ m^{-2} $year^{-1}$;

(the distinction between gross and net productivity will not be required);

(c) interpret data relating the productivity of a plant community to features of its environment:

- climate;
- sunlight intensity;
- carbon dioxide concentration;
- temperature and altitude;
- water and nutrient availability;

Biodiversity and selection

(d) define the terms *species* and *biodiversity* (as the number of separate species living in an ecosystem);

(e) explain the importance of the biodiversity of ecosystems:

- provision of resources such as medicines, food supply;
- the sustainability of an ecosystem;

(f) describe the process of natural selection:

- examples of natural changes to an ecosystem which create increased competition;
- the survival of the best-adapted organisms;
- the passing on of favourable characteristics to offspring;

(g) explain and compare the terms *adaptation* and *speciation;*

- exploration and discussion of human use of antibiotics and resulting changes in populations of bacteria would be a valuable example; this would allow discussion of the issues involved in using antibiotics in human therapies and as preventative medicines in agriculture.

(h) Describe the key features leading to speciation:

- geographical isolation;
- reproductive isolation;
- the cumulative effect of many generations of adaptation;

Ecosystem examples

(i) interpret data on marine and rainforest ecosystems and the impact of human actions on biodiversity, selection processes, species distribution and population levels.

- research examples of endangered species in marine and rainforest ecosystems relating their status to human activity.

Practical Skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments:

- use of Elodea to measure the rate of photosynthesis in varying conditions of light or temperature;
- investigation of effects of temperature, dissolved oxygen and chemical environment on water movement in a rooted cut stem, and hence on the role of respiration;
- investigation of plant growth with and without added nutrients;
- exploration of methods of detecting nutrient traces in water and soil;
- use measurement and extrapolation techniques to estimate biomass levels in different ecosystems.

3.2 AS Unit G642: *Science and Human Activity*

- This unit consists of **four** teaching modules

Module 1. **Weather, climate and climate change:**

2.1.1 the nature of the atmosphere;

2.1.2 the unique properties of water;

2.1.3 climate change.

Module 2. **Chemical processes in the atmosphere:**

2.2.1 acids and acid rain;

2.2.2 the effect of CFCs on ozone;

2.2.3 the greenhouse effect.

Module 3. **Proteins and genetic engineering:**

2.3.1 the biological roles of proteins;

2.3.2 DNA and genetic modification.

Module 4. **Options for energy generation:**

2.4.1 energy generation;

2.4.2 electrical energy.

Candidates are expected to apply knowledge, understanding and other skills gained in this unit to new situations and/or to resolve related problems.

Recommended Prior Knowledge

Candidates should:

- have achieved Grade C or above in both GCSE Science and GCSE Additional Science, or an equivalent standard in other appropriate Level 2 qualifications.

3.7 GCSE Science

(j) **Organisms and health:**

(c) the ways in which organisms function are related to the genes in their cells.

(ii) **Chemical and material behaviour:**

(a) chemical change takes place by the rearrangement of atoms in substances;

(b) there are patterns in the chemical reactions between substances.

(iii) **Energy, electricity and radiations:**

(a) energy transfers can be measured and their efficiency calculated, which is important in considering the economic costs and the environmental effects of energy use;

(b) electrical power is readily transferred and controlled, and can be used in a range of different situations;

(c) radiations, including ionising radiations can transfer energy;

(d) radiations in the form of waves can be used for communication.

(iv) **Environment, Earth and universe:**

(a) the effects of human activity on the environment can be assessed using living and non-living indicators;

(b) the surface and the atmosphere of the Earth have changed since the Earth's origin and are changing at present;

(c) the solar system is part of the universe, which has changed since its origin and continues to show long-term changes.

3.9 GCSE Additional Science

(ii) **Chemistry**

(a) **Structure and bonding**

The outer electrons of atoms are involved in chemical reactions. The structure and properties of a substance are strongly dependent on the nature of the bonding which results from the forces between the electrons and nuclei of atoms.

(iii) **Physics**

(b) **Nuclear changes**

Nuclear changes within unstable atoms cause random emission of particles. Nuclear changes

also cause the emission of energy in the form of useful and dangerous radiation.

(i) **Biology**

Cells and growth

Chemical reactions essential for life and growth take place inside cells. Differences between plant and animal cells lead to different patterns of growth and development.

G642 Module 1: 2.1 Weather, climate and climate change

Ideas about heat, energy and kinetic theory lead to a study of the atmospheric processes determining weather and climate. The effect of ocean currents is introduced and provides an opportunity to look at the nature of water in more detail. Finally, the evidence for climate change is examined and the latest models compared.

The following aspects of "How Science Works" may be assessed in this module:

3. Use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems.

5 b Analyse and interpret data to provide evidence, recognizing correlations and causal relationships.

c Evaluate methodology, evidence and data, and resolve conflicting evidence.

7 a Appreciate the tentative nature of scientific knowledge.

b Appreciate the role of the scientific community in validating new knowledge and ensuring integrity.

c Appreciate the ways in which society uses science to inform decision-making.

Links

Unit G641 Module 1: Remotely sensed data

Unit G641 Module 1: Electromagnetic radiation

Context and exemplification	Assessable learning outcomes
2.1.1 The nature of the atmosphere: • the nature of the atmosphere is examined and the vertical and horizontal movement of air is explained by using simple ideas about density and pressure derived from kinetic theory.	Candidates should be able to: (a) describe and use the simple molecular-kinetic theory of gases to explain pressure; (b) apply the relationships between pressure volume and temperature: • Boyle's Law; • Charles' Law; (c) apply the relationship, $P = F \div A$ (the units of pressure used will be N m^{-2}); (d) explain the energy transfers which accompany expansion and contraction of gases: • cooling due to work done against the atmosphere; • warming due to work done by the atmosphere; (e) describe the basic structure of the atmosphere: • the troposphere and stratosphere; • the tropopause; (f) describe the role of thermal energy, and the sources of this energy, in driving atmospheric circulation processes as exemplified by: • rising air at the Intertropical Convergence Zone (ITCZ); • hurricane formation; (g) summarise the principles affecting horizontal movement of air in the troposphere: • movement from high to low pressure; • the Coriolis effect; (h) describe the circulation of air in the troposphere and the distribution of general climate zones.

2.1.2 The unique properties of water:

- the unique properties of water are examined and used to explain the role of water in transferring energy; the structure of a water molecule is also used as an introduction to key ideas about covalent bonding, intermolecular forces and the shape of simple molecules;

- ideas about air and water are then used to explain a variety of weather events and climatic features.

Candidates should be able to:

(a) describe the features of covalent bonding
- the sharing of a pair of electrons;
- the role of the electrons in overcoming the repulsion of the nuclei;

(b) state that molecules may possess non-bonded pairs (lone pairs) of electrons;

(c) predict and interpret the shapes of simple molecules with up to four outer pairs of electrons around the atoms using electron pair repulsion theory (distinctions over the relative magnitudes are not required);

(d) explain how covalent bonds can be polar and that molecules can possess a permanent dipole;

(e) explain the meaning of the term *electronegativity;*

(f) deduce bond polarity from relative electronegativity values;

(g) describe the key features of hydrogen bonding:
- the requirement for a δ+ H atom;
- the requirement for small electronegative atoms (N,O and F);
- the role of the lone pair;
- the 180° bond angle around the hydrogen-bonded hydrogen;

(h) describe and explain the principal features of the structure of liquid water and ice:
- the bonding and shape of individual water molecules;
- hydrogen bonding between molecules of water;
- the temporary nature of the hydrogen bonds in liquid water;
- the open structure of ice caused by the tetrahedral arrangement of hydrogen bonds around each oxygen atom;

(i) explain the term *specific heat capacity* and use it to determine the energy transferred to water in heating processes;

(j) explain (in terms of intermolecular bond breaking and bond making) the energy changes which occur during vaporisation and condensation;

(k) explain the anomalous properties of water in terms of hydrogen bonding:
- boiling point;
- specific heat capacity;

	• enthalpy of vaporisation; • density change on freezing; (l) use the relationship, density = mass ÷ volume (density values will be expressed in g cm^{-3} or kg m^{-3}); (m) describe and explain the general circulation of water in the oceans and its effects on climate: • surface currents and sub-tropical gyres; • sinking of water by cooling and increased salinity in the North Atlantic and South Atlantic; • deep water currents; • the Gulf Stream, the North Atlantic Drift, the Norwegian Current; (n) explain the effects and significance of El Niño events and the North Atlantic Oscillation.
2.1.3 Climate change: • the evidence for climate change and its causes is examined, as is the range of models of global warming.	Candidates should be able to: (a) examine and evaluate the evidence for climate change and its likely causes (HSW 5b, 5c, 3, 7a, 7b): • ice-core data (isotopic ratios and gas analysis); • modern temperature records; • modern CO_2 measurements; • biological indicators (eg tree rings); (b) compare and contrast the models of future climate; (c) discuss the range of possible responses to the issue of climate change (HSW 7c): • use of alternative energy sources; • carbon sequestration; • political and economic strategies.

Practical Skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments:

- measurement of the specific heat capacity of water;
- measurement of the heat of vaporisation of water;
- experiments to find the relationships between pressure and volume (Boyle's law) and pressure and temperature (Charles' law);
- observation of the deflection of jets of liquids in electric fields to illustrate the presence of molecular dipoles.

Unit G642 Module 2: 2.2 Chemical Processes in the Atmosphere

The complex interactions between molecules and energy in the atmosphere provide an ideal opportunity for candidates to extend their understanding of chemical processes – for example, oxidation, acid–base reactions and the role of catalysts. As a result they will gain an in-depth knowledge of a range of environmental processes, their causes, effects, environmental patterns and possible solutions to the problems caused. The issue of global warming, introduced in Unit G642 Module 1, is developed by considering the way in which infrared radiation is absorbed.

The following aspects of "How Science Works" may be assessed in this module:

5 a Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts

Links:

Unit G642 Module 1: Evidence for climate change and its causes

Unit G642 Module 4: Devising strategies for reducing the effect of climate change

Unit G641 Module 1: Nature of IR and UV radiation

Context and exemplification	Assessable learning outcomes
2.2.1 Acids and acid rain: • the formation of acid rain is studied as a fairly familiar example of a process producing atmospheric pollution; the concept of oxidation number is introduced; molecular and/or full structural formulae may be used in questions; chemical equations will be used throughout this module to describe the following processes: • the formation of acidic pollutant gases; • the dissociation of acids; • the formation and removal of ozone ion the atmosphere; • combustion reactions of fossil fuels.	Candidates should be able to: (a) interpret and write balanced chemical equations as a model for representing chemical reactions; (b) interpret oxidation and reduction in terms of: • gain and loss of oxygen; • change in oxidation state [limited to reactions involved in the formation of acid rain]; (c) discuss the causes and effects of acid deposition: • the roles of sulfur oxides and nitrogen oxides; • effect of acid on stonework; • effect of pH changes on aquatic life; • the release of toxic metal ions from soils as a result of ion exchange; • susceptibility of different soil types to acid deposition; (d) discuss strategies used to minimise damage from acid deposition: • removing sulfur from fuels (candidates will not be expected to recall detailed methods); • the use of flue gas sulfurisation;

Questions will not be set requiring candidates to balance or recall other types of process, eg acid–base reactions, although such equations may be quoted in questions.	• catalytic converters to convert NO_x into N_2; • liming of lakes; (e) recall a model of an acid in terms of its ability to produce hydrogen ions; (f) define and apply the terms *strong acid* as an acid fully ionised in aqueous solution and *weak acid* as an acid only partially ionised in aqueous solution – the use of universal indicator (and pH meters) and the pH scale as a measure of acidity; (g) describe the use of titrations to compare the relative amounts of acid in a solution (mole calculations are not required) (HSW 5a).
2.2.2 The effect of CFCs on ozone:	Candidates should be able to:
• the effect of CFCs on ozone is used as a less familiar case study; the concept of catalysts and catalytic cycles will be introduced, as well as the term radical.	(a) describe the formation of ozone and its role in the atmosphere: • formation from oxygen in the presence of short wavelength ultraviolet radiation; • its role in the stratosphere in absorbing longer wavelength ultraviolet radiation; (b) describe the nature and structure of chlorofluorocarbon molecules as a man-made source of Cl atoms in the atmosphere; (c) interpret data (relating to boiling point and ozone depletion potential) to explain how CFCs have been replaced by other less damaging molecules; (d) define the term *radical* and identify radicals, given appropriate information; (e) explain the role of radicals, such as Cl and NO, in removing ozone, by appropriate chemical equations; (f) describe chemical reactions in terms of bond breaking and bond forming; (g) explain the term *activation energy* in terms of minimum energy required for bond breaking (to allow new bonds to form); (h) explain that catalysts provide alternative routes for reactions with lower activation energy; (i) explain the terms *heterolytic* and *homolytic* in the context of the action of: • heterolytic catalysts, such as platinum in catalytic converters; • homolytic catalysts such as chlorine atoms.

2.2.3 The greenhouse effect:	Candidates should be able to:
• the absorption of infrared radiation by CO_2 and other greenhouse gases is explained and developed and a link is made to the technique of infra-red spectroscopy.	(a) describe the factors affecting the frequency vibration of chemical bonds: • strength of the bond; • masses of the atoms; (b) interpret simple infra-red spectra to identify the bonds present (given suitable data); (c) apply the relationships between wavenumber, frequency, energy and wavelength: • wavenumber = 1/wavelength (the unit of wavenumber used will be cm^{-1}); • $E = hf$; • $c = f\lambda$; (d) describe how the absorption of infra-red radiation by carbon dioxide causes the greenhouse effect; (e) state other examples of greenhouse gases: • methane; • NO; • water vapour.

Practical Skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments:

- carry out some simple redox reactions (for example the production of NO_2 and SO_2 by the action of conc. nitric and sulfuric acids on copper can be demonstrated);
- the reactions of acids can be revised, particularly the effect of acid on calcium carbonate;
- carry out an acid-base titration;
- measure pH of soil and/or water samples (particularly samples which contain dissolved SO_2, NO_2 and CO_2).

Unit G642 Module 3: 2.3 Proteins and Genetic Engineering

The nature and role of proteins is studied, including their role as enzymes. The role of DNA in directing protein synthesis is then reviewed and the technique of genetic engineering is studied, in the context of the development of GM plants.

The following aspects of "How Science Works" may be assessed in this unit:

5 a Carry out experimental and investigative activities, including appropriate risk management, in a range of contexts;

b Analyze and interpret data to provide evidence, recognizing correlations and causal relationships;

c Evaluate methodology, evidence and data, and resolve conflicting evidence;

6 a Consider applications and implications of science and appreciate their associated benefits and risks;

b Consider ethical issues in the treatment of humans, other organisms and the environment.

Links:

Unit G642 Module 2: *pH and activation energy*

Unit G641 Module 2: *Respiration and photosynthesis*

Context and exemplification	Assessable learning outcomes
2.3.1 The biological roles of proteins:	Candidates should be able to:
• the range of biological roles of proteins is studied, focusing on enzymes and their central role in metabolism;	(a) describe the cellular roles of proteins; (b) describe the primary, secondary and tertiary structures of a protein: • primary structure as the amino acid sequence; • secondary structure as α-helix or β-pleated sheet; • tertiary structure as the folding of the chain into a complex three-dimensional structures; (c) describe the types of linkages responsible for maintaining these structures: • peptide links; • hydrogen bonds; • ionic interactions; • sulfur-sulfur links; (d) interpret ribbon and space-filled models of proteins; (e) state that enzymes are 'biological catalysts'; (f) describe the mode of enzyme action: • importance of the tertiary structure of enzymes;

- the lock and key model as an example of providing a mechanism for a reaction with a lower activation energy;
- the nature of the active site;
- enzyme specificity with respect to reaction and substrate;

(g) describe the factors that affect enzyme action:

- pH;
- temperature;
- enzyme concentration;
- substrate concentration;
- competitive and non-competitive inhibition (HSW 5a,b,c);

(h) describe the role of enzymes in some of the metabolic processes in cells, limited to one example in each of protein synthesis, respiration and photosynthesis.

2.3.2 DNA and genetic modification:

Candidates should be able to:

- the detailed structure of DNA is studied leading to the mechanism of protein synthesis. This in turn leads to an explanation of the process of genetic modification and the specific issue of GM crops is looked at in detail.

(a) describe the structure of DNA, and explain that genes are made up of sequences of nucleotides:

- the outline structure of nucleotides in terms of sugar, phosphate and base units (actual formulae are not required);
- the significance of base pairs and interactions between them;
- the structure of the double helix;

(b) describe how the DNA molecule is replicated;

(c) describe, in outline, the role of DNA in protein synthesis:

- the triplet code;
- the roles of messenger and transfer RNA and ribosomes;
- the link between the proteins produced and the phenotype of the organism;

(d) describe, in outline, the use of genetic engineering in the development of new crops:

- the use of restriction enzymes to isolate the required gene;
- the transfer of DNA into the genome of the receiving organism (limited to the use of viral vectors and micro-injection to create transgenic plants);

- the social, ethical and environmental implications of this technique (HSW 6a and b);

Practical Skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments:

- carry out experiments to explore how enzyme activity depends on substrate concentration, temperature and pH, eg using amylase and starch, hydrogen peroxide and catalase;
- carry out experiments on enzyme specificity (eg comparing the metabolism of glucose and sodium hexanoate by yeast);
- extract DNA from plant material (for example an onion).

Unit G642 Module 4: 2.4 Options for energy generation

The processes of fossil fuel combustion and nuclear fission are compared and ideas about atomic structure are developed. The strategies used to supply the electrical energy produced from power stations are discussed, leading to an exploration of some key ideas about electromagnetic fields and electrical energy.

The following aspects of "How Science Works" may be assessed in this unit:

1. Use theories, models and ideas to develop and modify scientific explanations
2. Use knowledge and understanding to pose scientific questions, define scientific problems, present scientific arguments and scientific ideas

5 c Evaluate methodology, evidence and data, and resolve conflicting evidence

6 a Consider applications and implications of science and appreciate their associated benefits and risks

Links:

Unit G642 Module 1: *Electronic structure*

Unit G642 Module 1: *Approaches to climate change*

Unit G642 Module 3: *Proteins and genetic engineering*

Context and exemplification	Assessable learning outcomes
2.4.1 Energy generation:	Candidates should be able to:
• the use of fossil fuels to generate energy, in the form of electricity is reviewed and evaluated. This is then contrasted with the use of nuclear fission. Nuclear fusion is also briefly considered.	(a) explain, in terms of bond breaking and forming, why fossil fuels produce energy (calculations involving bond energies are not required); (b) describe and interpret results from experiments to measure energy released by burning fuels; (c) discuss the environmental impact of burning fossil fuels; (d) describe a model for the structure of the atom in terms of a nucleus, composed of

protons and neutrons, and surrounding electrons;

(e) compare the masses and charges of protons, neutrons and electrons;

(f) use and explain the meanings of the following terms:

- *atomic number*;
- *mass number*;
- *isotope* (including use of conventional symbols for nuclides);

(g) describe the properties and identities of α, β, γ emissions;

(h) describe and compare the hazards associated with radioactive sources:

- radiation;
- contamination;

(i) explain the process of radioactive decay:

- the concept of half-life;
- the origins of ionising radiations;

(j) deduce nuclear equations from appropriate information;

(k) describe the principal natural and artificial sources of ionising radiation;

(l) explain what is meant by the terms *nuclear fusion* and *nuclear fission* and use nuclear equations to describe them;

(m) discuss how scientists are able to develop and use models of systems that cannot be investigated directly, with particular reference to the development of appropriate models for the structure of the atom to include:

- Thompson's plum pudding model;
- the Rutherford to model of the nuclear atom and the evidence used to support this model (HSW 1, 2);

(n) describe the options for future energy generation strategies and assess their relative advantages and disadvantages:

- burning fossil fuels;
- nuclear fission;
- nuclear fusion;
- alternative energy sources (to include wind, solar, wave and tidal) (HSW 6a).

2.4.2 Electrical energy:

- electrical supply networks, such as the National Grid, and the possible harmful effects of electromagnetic fields are considered;
- the use of epidemiology to assess the risk of exposure to electromagnetic fields and ionising radiation is also examined.

Candidates should be able to:

(a) describe the principal features of the electricity transmission and distribution system in the UK:
- the use of high voltages;
- the role of step-up and step-down transformers;

(b) describe the principal features of the electric and magnetic fields from overhead power lines, underground power cables and domestic wiring:
- the alternating nature of the fields;
- dependence on voltage and distance (electric fields);
- dependence of magnetic fields on the geometrical arrangement of the conductors and the patterns of current flow (details of fields from particular arrangements and current flows are not required);
- the use of three phase circuit lines and the effect on the net magnetic field;

(c) use the terms: *current*, *voltage*, *resistance*, *power* and their appropriate SI units;

(d) use the terms *ac* and *dc*

(e) select and use the following relationships
- current = charge / time
- power = voltage × current;

(f) apply the following: relationships:
- resistance = voltage / current
- power loss = $(\text{current})^2 \times$ resistance;

(g) explain the principal features of electrical and magnetic fields:
- a field as a region of space in which charges or magnetic poles experience forces;
- the use of field lines to describe the strength and effect of a field;

(h) describe the use of epidemiological studies to evaluate the risks of:
- exposure to alternating electromagnetic fields (power lines or mobile phone masts);
- exposure to various doses of ionising radiation (HSW 5c).

Practical Skills are assessed using OCR set tasks. The practical work suggested below may be carried out as part of skill development. Centres are not required to carry out all of these experiments:

- measure the energy released by burning fuels (for example alcohols);
- demonstrate the properties of α,β and γ emissions;
- carry out experiments to find the relationship between voltage and current for a resistor;
- carry out experiments to illustrate the presence of magnetic fields around permanent magnets and current-carrying wires.

3.3 AS Unit G643: *Practical Skills in Science*

In addition to the aims of the scheme, this unit develops practical and investigative skills within contexts encountered during AS Science.

Candidates are required to carry out **two** task types:

1. Case study [15 marks]

2. Practical task [25 marks]

Candidates will produce the written report on the case study under controlled conditions in the classroom.

Candidates will carry out the whole of the practical task in the laboratory.

Candidates may attempt more than one task from each category with the best mark from each category being used to make up the Candidate's final mark.

One mark will be required from each task type with an overall mark out of 40 being submitted to OCR.

AO3: How Science Works

Candidates will be required to:

5 a Demonstrate and describe ethical, safe and skilful practical techniques and processes selecting appropriate qualitative and quantitative methods;

5 b Make, record and communicate reliable and valid observations and measurements with appropriate precision and accuracy;

5 c Analyse, interpret and explain the methodology, results and impact of their own and others' experimental and investigative activities in a variety of ways.

Context and exemplification	Accessible learning outcomes
1. Case study A single mark out of 15 will be submitted. Candidates will be required to use secondary and/or primary sources to investigate a specific area of scientific research or study. They will then produce a short report. This report will require candidates to: • demonstrate understanding of the science underlying the study; • demonstrate understanding of the practical techniques used by the scientists involved in the research, including any ethical issues; • process, analyse or explain the data in a way which allows them to identify the main conclusions, patterns or trends in the research of these scientists; • consider the reliability and validity of the data; • demonstrate that they have used a variety of sources. Tasks will be provided by OCR, including stimulus material and mark schemes. Each task will be teacher marked. Reading, research and preliminary discussion may be carried out in any appropriate way. However the final report must be produced under controlled conditions in the classroom or laboratory.	(a) Select and use suitable sources of information and data (including appropriate referencing techniques); (b) Demonstrate understanding of the ethical, safe and skilful techniques and processes used by other scientists; (c) Explain and evaluate the results of the work of other scientists.
2. Practical task Candidates carry out a practical task using instructions supplied by OCR. Candidates carry out an analysis of the data obtained and an evaluation of their procedure. Tasks and specific mark schemes (based on the adjacent generic criteria) will be provided by OCR. Each task will be teacher marked.	(a) Demonstrate safe and skilful practical techniques, to include: • appreciation of the nature of hazards in scientific work and take appropriate precautions. (b) Make and record observations with appropriate precision and accuracy, to include: • make and record measurements to an appropriate degree of accuracy and precision; • organise and communicate results in a suitable way. (c) Analyse and interpret results to reach valid conclusions.

A single mark out of 25 will be submitted.	(d) Evaluate the methodology used in experimental work, to include: • assessing the reliability and accuracy of experimental results; • identify weaknesses in an experimental method; • select simple improvements to experimental procedures.

The Tasks

Tasks, mark schemes and guidance for teachers and technicians can be downloaded from the OCR Interchange site.

Further advice and guidance on the use and marking of the tasks can be found in the Practical Skills Handbook.

4 Schemes of Assessment

4.1 AS GCE Scheme of Assessment

AS GCE Science (H178)	
AS Unit G641: *Remote Sensing and the Natural Environment*	
30% of the total AS GCE marks 1 h written paper 60 marks	Candidates answer all questions.
AS Unit G642: *Science and Human Activity*	
50% of the total AS GCE marks 1.75 h written paper 100 marks	Candidates answer all questions.
AS Unit G643: *Practical Skills in Science*	
20% of the total AS GCE marks Coursework 40 marks	Candidates complete two tasks set by OCR. Tasks are marked by the centre using mark schemes provided by OCR.

4.2 Unit Order

The normal order in which the unit assessments could be taken is AS Units G641, G642 and G643, leading to an AS GCE award.

4.3 Unit Options (at AS)

There are no optional units in the AS GCE specification; for AS GCE Science, candidates must take AS Units G641, G642 and G643.

4.4 Assessment Availability

There is one examination series each year in June.

From 2014, AS units will be assessed in June only.

4.5 Assessment Objectives

Candidates are expected to demonstrate the following in the context of the content described:

AO1 Knowledge and Understanding

- recognise, recall and show understanding of scientific knowledge;
- select, organise and communicate relevant information in a variety of forms.

AO2 Application of Knowledge and Understanding

- analyse and evaluate scientific knowledge and processes;
- apply scientific knowledge and processes to unfamiliar situations including those related to issues;
- assess the validity, reliability and credibility of scientific information.

AO3 How Science Works

- demonstrate and describe ethical, safe and skilful practical techniques and processes, selecting appropriate qualitative and quantitative methods;
- make, record and communicate reliable and valid observations and measurements with appropriate precision and accuracy;
- analyse, interpret, explain and evaluate the methodology, results and impact of their own and others' experimental and investigative activities in a variety of ways.

AO weightings in AS GCE

Unit	% of AS GCE			Total
	AO1	AO2	AO3	
AS Unit G641: *Remote Sensing and the Natural Environment*	14	14	2	30%
AS Unit G642: *Science and Human Activity*	21	24	5	50%
AS Unit G643: *Practical Skills in Science*	3	2	15	20%
	38%	40%	22%	100%

4.6 Quality of Written Communication

Quality of written communication is assessed in all units and credit may be restricted if communication is unclear.

Candidates will:

- 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 purpose and to complex subject matter;
- organise information clearly and coherently, using specialist vocabulary when appropriate.

5 Technical Information

5.1 Making Unit Entries

Please note that centres must be registered with OCR in order to make any entries, including estimated entries. It is recommended that centres apply to OCR to become a registered centre well in advance of making their first entries. Centres must have made an entry for a unit in order for OCR to supply the appropriate forms or moderator details for coursework.

It is essential that unit entry codes are quoted in all correspondence with OCR. See Sections 4.1 and 4.2 for these unit entry codes.

5.2 Making Qualification Entries

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

Candidates may enter for:

- AS GCE certification (entry code H178).

A candidate who has completed all the units required for the qualification, and who did not request certification at the time of entry, may enter for certification either in the same examination series (within a specified period after publication of results) or at a later series.

AS GCE certification is available from June 2014.

5.3 Grading

All GCE units are awarded a-e. The Advanced Subsidiary GCE is awarded on the scale A-E. Grades are reported on certificates. Results for candidates who fail to achieve the minimum grade (E or e) will be recorded as unclassified (U or u) and this is **not** certificated.

A Uniform Mark Scale (UMS) enables comparison of candidates' performance across units and across series. The three-unit AS GCE has a total of 300 *uniform* marks.

OCR converts the candidate's raw mark for each unit to a *uniform* mark. The maximum *uniform* mark for any unit depends on that unit's weighting in the specification. In this Science specification the three units of the AS GCE specification have *uniform* mark weightings of 30%/50%/20%. The *uniform* mark totals are 90/150/60, respectively. Each unit's *raw* mark grade boundary equates to

the *uniform* mark boundary at the same grade. Intermediate marks are converted on a pro-rata basis.

Uniform marks correspond to *unit* grades as follows:

(AS GCE) Unit Weighting	Maximum Unit Uniform Mark	Unit Grade					
		a	b	c	d	e	u
50%	150	150–120	119–105	104–90	89–75	74–60	59–0
30%	90	90–72	71–63	62–54	53–45	44–36	35–0
20%	60	60–48	47–42	41–36	35–30	29–24	23–0

OCR adds together the unit *uniform* marks and compares these to pre-set boundaries (see the table below) to arrive at *qualification* grades.

Qualification	Qualification Grade					
	A	B	C	D	E	U
AS GCE	300–240	239–210	209–180	179–150	149–120	119–0

5.4 Result Enquiries and Appeals

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

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

5.5 Shelf-life of Units

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

5.6 Unit and Qualification Re-sits

There is no restriction on the number of times a candidate may re-sit each unit before entering for certification for an AS GCE.

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

5.7 Guided Learning Hours

AS GCE Science requires **180** guided learning hours in total.

5.8 Code of Practice/Subject Criteria/Common Criteria Requirements

This specification complies in all respects with current *GCSE, VCE, GNVQ and AEA Code of Practice* as available on the QCA website, the subject criteria for GCE Science and *The Statutory Regulation of External Qualifications 2004*.

5.9 Arrangements for Candidates with Particular Requirements

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

5.10 Prohibited Qualifications and Classification Code

Candidates who enter for the OCR GCE specifications may not also enter for any other AS GCE specification with the certification title *Science* in the same examination series.

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

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

The classification code for this specification is 1310.

5.11 Coursework Administration/Regulations

Supervision and Authentication

As with all coursework, teachers must be able to verify that the work submitted for assessment is the candidate's own work. Sufficient work must be carried out under direct supervision to allow the teacher to authenticate the coursework marks with confidence.

Submitting marks to OCR

Centres must have made an entry for a unit in order for OCR to supply the appropriate forms or moderator details for coursework. Coursework administration documents are sent to centres on the basis of estimated entries. Marks may be submitted to OCR either via Interchange, on the computer-printed Coursework Mark Sheets (MS1) provided by OCR (sending the top copy to OCR and the second copy to their allocated moderator) or by EDI (centres using EDI are asked to print a copy of their file and sign it before sending to their allocated moderator).

The deadline for the receipt of coursework marks is 15 May.

The awarding body must require centres to obtain from each candidate a signed declaration that authenticates the coursework they produce as their own. For regulations governing coursework, centres should consult the OCR *Administration Guide for General Qualifications.* Further copies of the coursework administration documents are available on the OCR website (www.ocr.org.uk).

Standardisation and Moderation

All internally-assessed coursework is marked by the teacher and internally standardised by the centre. Marks must be submitted to OCR by the agreed date, after which postal moderation takes place in accordance with OCR procedures.

The purpose of moderation is to ensure that the standard for the award of marks in internally-assessed coursework is the same for each centre, and that each teacher has applied the standards appropriately across the range of candidates within the centre.

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

Minimum Coursework Required

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

6 Other Specification Issues

6.1 Overlap with other Qualifications

Links with other AS GCE specifications.

This course provides overlap with other AS Level science specifications. The specification in science emphasises links between chemistry and related subjects such as biology, geology and physics.

Examples of overlap include:

Biology

- Unit G642: *Science and Human Activity***.** Amino acids, proteins, DNA

Geology

- Unit G642: *Science and Human Activity*. Climate change, the atmosphere.

Physics

- Unit G641: *Remote Sensing and the Natural Environment.* The wave behaviour of light, applications of electromagnetic radiation.
- Unit G642: *Science and Human Activity*. Atomic structure.

Chemistry

- Unit G642: *Science and Human Activity*. Atomic structure.
- Unit G642: *Science and Human Activity.* Climate change, the atmosphere, the development of renewable alternatives to finite energy resources, enthalpy changes, rates of reaction, catalysis.
- Unit G642: *Science and Human Activity*. Amino acids, proteins, infrared spectroscopy.

6.2 Progression from these Qualifications

Four principal candidate audiences are envisaged for AS GCE Science. For the first audience, learning science will form part of their education as members of society in general. These candidates are unlikely to continue a formal study of science into their adult lives. The AS Science specification has been designed to meet the needs of such candidates and to promote their lifelong interest in science.

The second principal audience consists of those who are likely to make more direct use of science in their lives, for example, those whose jobs, although not primarily in science, will involve some contact with science. The AS specification has been designed to provide these candidates with a broad study of science.

The third candidate audience comprises those taking AS Science as part of an accelerated programme in Key Stage 4; they may do so having taken GCSE Science early or as an alternative to it. Such able candidates may progress to courses leading to GCE A/AS Sciences post-16.

The fourth candidate audience comprises adult learners who may find it helpful to study broad and balanced science at AS GCE when re-entering the education system with a view to making career changes.

The two latter types of candidate may progress to higher education to specialise in one of the science disciplines.

6.3 Key Skills Mapping

This specification provides opportunities for the development of the Key Skills of *Communication*, *Application of Number*, *Information Technology*, *Working with Others*, *Improving Own Learning and Performance* and *Problem Solving* at Levels 2 and/or 3. However, the extent to which this evidence fulfils the Key Skills criteria at these levels will be totally dependent on the style of teaching and learning adopted for each unit.

The following table indicates where opportunities *may* exist for at least some coverage of the various Key Skills criteria at Levels 2 and/or 3 for each unit.

Unit	C				AoN			IT			WwO			IoLP			PS		
	.1a	.1b	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3
G641	✓	✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
G642	✓	✓						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
G643				✓	✓	✓	✓	✓	✓	✓									

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

This specification offers opportunities which can contribute to an understanding of these issues in the following topics:

- the endeavour of science in describing its structure and functioning;
- the scale and impact of natural processes and phenomena;
- the importance of the Sun, plant life and micro-organisms to processes on Earth.

6.5 Sustainable Development, Health and Safety Considerations and European Developments

This specification supports these issues, consistent with current EU agreements, in the following topics:

- the health hazards of different types of radiation;
- the impact of human actions on biodiversity and on the survival of endangered species;
- the effect of CFCs on ozone;
- the causes and effects of acid rain.

Although this specification does not make specific reference to scientific aspects of the European Union, it may be drawn into the course in a number of ways, for example in relation to issues of acid deposition and trans-boundary pollution in Europe.

6.6 Avoidance of Bias

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

6.7 Language

This specification and associated assessment materials are in English only.

6.8 Disability Discrimination Act Information Relating to these Specifications

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

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

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments. For this reason, very few candidates will have a complete barrier to any part of the assessment. Information on reasonable adjustments is found in *Access Arrangements and Special Consideration Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examinations* produced by the Joint Council (refer to Section 5.9 of this specification).

Candidates who are still unable to access a significant part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award. They would be given a grade on the parts of the assessment they have taken and there would be an indication on their certificate that not all of the competences have been addressed. This will be kept under review and may be amended in the future.

Practical assistants may be used for manipulating equipment and making observations. Technology may help visually impaired students to take readings and make observations.

Appendix A: Performance Descriptions

Performance descriptions have been created for all GCE subjects. They describe the learning outcomes and levels of attainment likely to be demonstrated by a representative candidate performing at the A/B and E/U boundaries for AS and A2.

In practice most candidates will show uneven profiles across the attainments listed, with strengths in some areas compensating in the award process for weaknesses or omissions elsewhere. Performance descriptions illustrate expectations at the A/B and E/U boundaries of the AS and A2 as a whole; they have not been written at unit level.

Grade A/B and E/U boundaries should be set using professional judgement. The judgement should reflect the quality of candidates' work, informed by the available technical and statistical evidence. Performance descriptions are designed to assist examiners in exercising their professional judgement. They should be interpreted and applied in the context of individual specifications and their associated units. However, performance descriptions are not designed to define the content of specifications and units.

The requirement for all AS and A level specifications to assess candidates' quality of written communication will be met through one or more of the assessment objectives.

The performance descriptions have been produced by the regulatory authorities in collaboration with the awarding bodies.

AS performance descriptions for science

	Assessment Objective 1	Assessment Objective 2	Assessment Objective 3
Assessment Objectives	**Knowledge and understanding of science and of How Science Works** Candidates should be able to: • recognise, recall and show understanding of scientific knowledge; • select, organise and communicate relevant information in a variety of forms.	**Application of knowledge and understanding of science and of How Science Works** Candidates should be able to: • analyse and evaluate scientific knowledge and processes; • apply scientific knowledge and processes to unfamiliar situations including those related to issues; • assess the validity, reliability and credibility of scientific information.	**How Science Works** Candidates should be able to: • demonstrate and describe ethical, safe and skilful practical techniques and processes, selecting appropriate qualitative and quantitative methods; • make, record and communicate reliable and valid observations and measurements with appropriate precision and accuracy; • analyse, interpret, explain and evaluate the methodology, results and impact of their own and others' experimental and investigative activities in a variety of ways.
A/B boundary Performance Descriptions	Candidates characteristically: a) demonstrate knowledge and understanding of most principles, concepts and facts from the AS specification; b) select relevant information from the AS specification; c) organise and present information clearly in appropriate forms using scientific terminology.	Candidates characteristically: a) apply principles and concepts in familiar and new contexts involving only a few steps in the argument; b) describe significant trends and patterns shown by data presented in tabular or graphical form; interpret phenomena with few errors; and present arguments and evaluations clearly; c) comment critically on statements, conclusions or data; d) carry out appropriate calculations specified for AS with few errors; e) translate successfully data that is presented as prose, diagrams, drawings, tables or graphs from one form to another.	Candidates characteristically: a) devise and plan experimental and investigative activities, selecting appropriate techniques; b) demonstrate safe and skilful practical techniques and comment effectively on ethical issues; c) make observations and measurements with appropriate precision and record them methodically; d) interpret, explain, evaluate and communicate the results of their own and others' experimental and investigative activities, in appropriate contexts.

E/U boundary Performance Descriptions	Candidates characteristically: a) demonstrate knowledge and understanding of some principles and facts from the AS specification; b) select some relevant information from the AS specification; c) present information using basic terminology from the AS specification.	Candidates characteristically: a) apply a given principle to material presented in familiar or closely related contexts involving only a few steps in the argument; b) describe some trends or patterns shown by data presented in tabular or graphical form; c) identify, when directed, inconsistencies in conclusions or data; d) carry out straightforward calculations from the AS specification; e) translate data successfully from one form to another, in some contexts.	Candidates characteristically: a) devise and plan some aspects of experimental and investigative activities; b) demonstrate safe practical techniques and comment on ethical issues; c) make observations and measurements and record them; d) interpret, explain and communicate some aspects of the results of their own and others' experimental and investigative activities, in appropriate contexts.

Appendix B: How Science Works

References in this specification to How Science Works (HSW) are to the following statements. These have been written by rearranging the statements in Section 3.6 of the QCA Subject Criteria.

1. Use theories, models and ideas to develop and modify scientific explanations.
2. Use knowledge and understanding to pose scientific questions, define scientific problems and present scientific arguments and ideas.
3. Use appropriate methodology, including ICT, to answer scientific questions and solve scientific problems.
4. Communicate information and ideas in appropriate ways using appropriate terminology.
5. Obtaining, analysing and evaluation data:
    a. carry out experimental and investigative activities, including appropriate risk management, in a range of contexts;
    b. analyse and interpret data to provide evidence, recognising correlations and causal relationships;
    c. evaluate methodology, evidence and data, and resolve conflicting evidence.
6. Applications, implications and ethical considerations:
    a. consider applications and implications of science and appreciate their associated benefits and risks;
    b. consider ethical issues in the treatment of humans, other organisms and the environment.
7. Scientific knowledge in its social context:
    a. appreciate the tentative nature of scientific knowledge;
    b. appreciate the role of the scientific community in validating new knowledge and ensuring integrity;
    c. appreciate the ways in which society uses science to inform decision-making.

Appendix C: Mathematical Requirements

In order to be able to develop their skills, knowledge and understanding in science, students need to have been taught, and to have acquired competence in, the appropriate areas of mathematics relevant to the subject as indicated below.

1. Arithmetic and numerical computation:

   (a) recognise and use expressions in decimal and standard form;

   (b) use ratios, fractions and percentages;

   (c) make estimates of the results of calculations (without using a calculator);

   (d) use calculators to find and use power, exponential and logarithmic functions.

2. Handling data:

   (a) use an appropriate number of significant figures;

   (b) find arithmetic means;

   (c) construct and interpret frequency tables and diagrams, bar charts and histograms;

   (d) understand simple probability;

   (e) understand the principles of sampling as applied to scientific data;

   (f) understand the terms mean, median and mode;

   (g) use a scatter diagram to identify a correlation between two variables;

   (h) use a simple statistical test;

   (i) make order of magnitude calculations.

3. Algebra:

   (a) understand and use the symbols: =, <, <<, >>, >, μ, ~;

   (b) substitute numerical values into algebraic equations using appropriate units for physical quantities.

4. Graphs:

   (a) translate information between graphical, numerical and algebraic forms;

   (b) plot two variables from experimental or other data;

   (c) understand that $y = mx + c$ represents a linear relationship.

5. Geometry and trigonometry:

   (a) visualise and represent two-dimensional (2D) and three-dimensional (3D) forms including 2D representations of 3D objects;

   (b) calculate areas of triangles, circumferences and areas of circles, surface areas and volumes of rectangular blocks, cylinders and spheres.

Appendix D: Health and Safety

In UK law, health and safety is the responsibility of the employer. For most establishments entering candidates for AS and Advanced GCE, this is likely to be the local education authority or the governing body. Employees, i.e. teachers and lecturers, have a duty to cooperate with their employer on health and safety matters. Various regulations, but especially the COSHH Regulations 2002 and the Management of Health and Safety at Work Regulations 1999, require that before any activity involving a hazardous procedure or harmful micro-organisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment. A useful summary of the requirements for risk assessment in school or college science can be found at www.ase.org.uk/htm/teacher_zone/safety_in_science_education.php.

For members, the CLEAPSS® guide, *Managing Risk Assessment in Science** offers detailed advice. Most education employers have adopted a range of nationally available publications as the basis for their Model Risk Assessments. Those commonly used include:

- *Safety in Science Education*, DfEE, 1996, HMSO, ISBN 0 11 270915 X.

  Now out of print but sections are available at:
  www.ase.org.uk/htm/teacher_zone/safety_in_science_education.php;

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

- *Safeguards in the School Laboratory*, 11th edition, 2006, ASE ISBN 978 0 86357 408 5;

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

- CLEAPSS® *Laboratory Handbook**;

- *Hazardous Chemicals*, A Manual for Science Education, 1997, SSERC Limited

  ISBN 0 9531776 0 2 (see www.sserc.org.uk/public/hazcd/whats_new.htm).

Where an employer has adopted these or other publications as the basis of their model risk assessments, an individual school or college then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment.

Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate or the skills of the candidates were insufficient to attempt particular activities safely. The significant findings of such risk assessment should then be recorded, for example on schemes of work, published teachers guides, work sheets, etc. There is no specific legal requirement that detailed risk assessment forms should be completed, although a few employers require this.

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

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

Appendix E: Using OCR Interchange to download Practical Skills tasks

All materials for the assessment of GCE AS Science Practical Skills can be obtained from OCR Interchange.

How to use OCR Interchange
OCR Interchange is a secure extranet enabling registered users to administer qualifications on-line. Your Examinations Officer is probably using OCR Interchange to administer qualifications already. If this is not the case, then your centre will need to register.

Your Examinations Officer will be able to:*

- download the relevant documents for you by adding the role of 'Science Coordinator' to their other roles or
- create a new user account for you (adding the Science Coordinator role) so that you can access the GCE AS Science pages and download documents when you need them.*

*Note that in order to assign the role of Science Coordinator to others, the Examinations Officer will need to hold the role of Centre Administrator.

The website address for Interchange is:

https://interchange.ocr.org.uk

The teacher who has downloaded these materials is responsible for ensuring that any pages labelled **confidential** are stored securely so that students do not have the opportunity to access them.

It is intended that the circulation of the Practical Tasks is limited to those students who are currently undertaking that task. These materials should be photocopied and issued to students at the start of the task. Numbering the documents may help to keep track of them.

Registering for Interchange

If your Examinations Officer is not already a registered user of Interchange then he/she will need to register before the Science Tasks can be downloaded.

This is a straightforward process:

- Go to the website – https://interchange.ocr.org.uk
- The first page has a New User section
- Click on Sign Up to access the OCR Interchange Agreement Form 1
- Download this document and fill in your details
- Return form by post to OCR Customer Contact Centre, Westwood Way, Coventry, CV4 8JQ or fax the form back to 024 76 851633
- OCR will then contact the Head of Centre with the details needed for the Examinations Officer to access OCR Interchange.