# GCE

Rewarding Learning

CCEA GCE Specification in

# Environmental Technology

For first teaching from September 2016
For first award of AS level in Summer 2017
For first award of A level in Summer 2018
Subject Code: 3930

# Foreword

This booklet contains CCEA's Advanced Subsidiary (AS) and Advanced GCE Environmental Technology for first teaching from September 2016.

The AS is the first part of the full Advanced GCE course. It is possible to take the AS as a stand-alone qualification. The AS units are assessed at a standard appropriate for students who have completed half of the full course.

The A2 is the second part of the full Advanced GCE course. Assessed at a standard appropriate for students who have completed the full course, the A2 units include both synoptic assessment (to assess students' overall learning throughout the course) and an element of stretch and challenge.

The full Advanced GCE award is based on students' marks from the AS (40 percent) and the A2 (60 percent). We award a grade A* to students who achieve both an A grade in the full A Level qualification and at least 90 percent of the maximum uniform marks available across the A2 units.

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.

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|---|---|
| Subject Code | 3930 |
| QAN AS Level | 601/8915/0 |
| QAN A Level | 601/8916/2 |

# Contents

# 1 Introduction

This specification sets out the content and assessment details for our Advanced Subsidiary (AS) and Advanced Level (A Level) courses in Environmental Technology. First teaching begins from September 2016. You can view and download the latest version of this specification on our website at www.ccea.org.uk

Students can take the AS course as a final qualification or as the first half of the A Level course. They must also complete the A2 course (the second half of the A Level) if they wish to obtain a full A Level qualification. We will make the first AS awards for this specification in 2017 and the first A Level awards in 2018.

The specification builds on the broad objectives of the Northern Ireland Curriculum.

This science-based specification focuses on technological solutions to the energy and environmental problems facing the world today. It highlights the need to manage our planet's resources more effectively and explores how our society will make the transition to a more sustainable way of living.

The A Level award provides a sound basis for study in Further and Higher Education either in a design or a technical area. It also develops planning, problem solving and independent study skills that are highly valued in the world of work.

Our GCE Environmental Technology is an applied qualification in which students develop knowledge, understanding and skills through practical demonstration and/or in a context related to employability.

As with all GCEs, the guided learning hours for this specification are:

- 180 hours for the Advanced Subsidiary award; and
- 360 hours for the Advanced Level award.

## 1.1 Aims

This specification allows opportunities for students to:

- develop their interest in science and technology along with an enthusiasm for environmental action;
- appreciate how science and technology can contribute towards a sustainable economy and society;
- develop their awareness of the complex interdependency between human populations and the environment on a local and global scale;
- understand the concept of sustainability and the role of environmental technology in present day and future society;
- apply their skills to relevant work-related scenarios;
- develop decision-making skills;
- research, develop and present their findings in a variety of formats;
- develop advanced study skills in preparation for third level education; and
- demonstrate their understanding and application of key concepts through challenging internal and external assessments.

## 1.2 Key features

The key features of the specification appear below.

- It gives students the opportunity to develop subject knowledge, understanding and skills in relation to a work context.
- The A Level course includes four assessment units: two externally assessed and two internally assessed.
- Assessment at A2 includes stretch and challenge, reflected in the use of a wider range of question types, higher demand evaluative tasks, synoptic assessment, and extended writing.
- A course of study based on this specification provides a sound basis for progression to third level education.

## 1.3 Prior attainment

The AS specification builds on, but does not depend upon, the knowledge, understanding and skills developed in GCSE Double Award Science, GCSE Physics, GCSE Chemistry, GCSE Biology, GCSE Mathematics and GCSE Technology and Design. The A2 specification builds on the knowledge, understanding and skills developed in the AS course.

## 1.4 Classification codes and subject combinations

Every specification is assigned a national classification code that indicates the subject area it belongs to. The classification code for this qualification is 3930.

### 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 GCEs. The same view may be taken if students take two GCE qualifications that have different classification codes but have content that overlaps slightly. Students who have any doubts about their subject combinations should check with the university or college that they wish to attend before embarking on their planned study.

# 2 Specification at a Glance

The table below summarises the structure of the AS and A Level courses:

| Content | Assessment | Weightings | Availability |
|---|---|---|---|
| **AS 1:**<br>**The Earth's Capacity to Support Human Activity** | External written examination<br><br>**1 hour 30 mins** | 50% of AS<br><br>20% of A Level | Every Summer from 2017 |
| **AS 2:**<br>**Renewable Energy Technologies** | Internal assessment<br><br>Students produce a technical report based on a realistic scenario relating to the use of renewable energy technologies.<br><br>Externally moderated | 50% of AS<br><br>20% of A Level | Every Summer from 2017 |
| **A2 1:**<br>**Building and Managing a Sustainable Future** | External written examination<br><br>**2 hours** | 30% of A Level | Every Summer from 2018 |
| **A2 2:**<br>**Environmental Building Performance and Measurement** | Internal assessment<br><br>Students produce a technical report relating to the environmental performance of a local building.<br><br>Externally moderated | 30% of A Level | Every Summer from 2018 |

# 3 Subject Content

We have divided the AS course into two units: AS 1 and AS 2. Students following the A Level course must study a further two units: A2 1 and A2 2. The content of each of these units is set out below.

## 3.1 Unit AS 1: The Earth's Capacity to Support Human Activity

Increased awareness of the impact of climate change challenges governments and has led scientists and engineers to a deeper understanding of the links between climate change and human activity. Population growth and an increase in resource consumption mean we should be more aware of the effects of fossil fuel use and develop more sustainable sources of energy.

This unit addresses the impacts of declining fossil fuel supplies and considers options for reducing global dependency on crude oil. Students examine the macrogeneration, distribution and storage of electricity from non-fossil fuel sources, as well as considering using renewable energy technologies on a micro level. To gain a fuller understanding of the content of AS 1, students should carry out practical activities in relation to aspects of three major renewable energy sources: wind, solar and biomass. They also take account of health and safety practices when carrying out practical work.

| **Content** | **Learning Outcomes** |
|---|---|
| **Reliance on Fossil Fuels** | Students should be able to:<br>• list coal, oil and gas as the principal fossil fuels on Earth;<br>• understand the importance of fossil fuels in the development of modern society by examining their uses as energy sources and as raw materials for manufacturing:<br>– plastics;<br>– pharmaceutics;<br>– transport; and<br>– fibres;<br>• present the case for global action on fossil fuel conservation, referring to lifespan, location of reserves and accessibility;<br>• discuss and draw conclusions from the evidence presented by the global scientific community, for example the Intergovernmental Panel on Climate Change (IPCC), linking the combustion of fossil fuels with global warming and climate change;<br>• explain the concept of carbon trading; and<br>• comment on the value of carbon trading schemes as a viable option for reducing global carbon emissions. |

| Content | Learning Outcomes |
| --- | --- |
| **Counting the Cost of Reliance on Fossil Fuels** | Students should be able to:<br>• recognise the trends in fossil fuel (coal, oil, gas) use in industrialised western countries;<br><br>• discuss the global economic impact of key emerging economies (for example Brazil, Russia, India and China) in relation to demand for fossil fuel supplies;<br><br>• explain the concept of fuel security and understand how the global demand for finite fossil fuel supplies influences geopolitics across the world;<br><br>• assess the environmental impact resulting from the global use of fossil fuels, with reference to:<br>– habitat degradation;<br>– impact on biodiversity;<br>– air quality reduction; and<br>– land and water contamination; |
| **Global Action on Energy Conservation and Climate Change** | • relate the Brundtland Commission's definition of sustainable development to significant global agreements on energy conservation and climate change;<br><br>• state the main European, UK and Northern Ireland targets for 2020 aimed at reducing greenhouse gas emissions and improving energy efficiency;<br><br>• relate the need to prioritise renewable energy development and reduce energy consumption to the framework of national and international environmental targets;<br><br>• discuss the use of nuclear power as a viable alternative to both fossil fuels **and** renewable energy sources (including a reference to energy density); |
| **Power Generation**<br><br>Macrogeneration | • demonstrate knowledge and understanding of the Law of Conservation of Energy;<br><br>• demonstrate how a simple wind generator works; and<br><br>• outline the main phases in the large-scale generation of electricity from fossil fuels, that is the combustion of fuel to produce steam which is used to drive a turbine coupled to a generator. |

| Content | Learning Outcomes |
|---|---|
| Macrogeneration (cont.) | Students should be able to:<br>• explain how renewable energy sources can be used directly (wind, hydroelectric, wave and tidal) or indirectly (solar photovoltaic (PV) or biomass) to generate electricity;<br>• identify the energy changes involved in generating electricity from each of the following renewable energy sources:<br>– wind;<br>– solar;<br>– hydroelectric;<br>– tidal;<br>– wave; and<br>– biomass;<br>• describe how electricity is distributed through the National Grid;<br>• explain the concept of a smart grid and outline how it can facilitate incorporating electricity generated from renewable energy sources;<br>• discuss the environmental and long-term economic benefits of the development of a smart grid using Irish, UK and European interconnections;<br>• describe the role of Combined Heat and Power (CHP), also known as cogeneration, in improving energy efficiencies in traditional power plants; |
| Microgeneration | • define microgeneration as the small scale generation of heat and power;<br>• list the main sources of microgeneration in microelectricity technologies (solar PV, wind), and microheat technologies (solar thermal, ground source heat pumps and biomass);<br>• identify the main benefits of home/community microgeneration, including reduced energy costs, contribution to environmental targets, enhanced security of supply and financial incentives; and<br>• demonstrate an understanding of heat pump technology, referring to the role of the condenser, evaporator, compressor, expansion valve and refrigerant. |

<table>
<tr><th>Content</th><th>Learning Outcomes</th></tr>
<tr><td>Microgeneration (cont.)<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br>Energy from Wind</td><td>Students should be able to:<br>• demonstrate how a heat pump/refrigeration unit works;<br>• describe the application of heat pump technology in relation to air source and ground source heat pumps;<br>• recall, understand and use the equation:<br>$$\text{Coefficient of Performance (COP)} = \frac{\text{heat produced by heat pump}}{\text{energy consumed by heat pump}}$$<br>• identify the common types of closed-loop ground heat source pump systems available for domestic homes, including:<br>– vertical;<br>– horizontal; and<br>– pond;<br>• describe the differences between the two main types of wind turbine:<br>– Vertical Axis Wind Turbine (VAWT); and<br>– Horizontal Axis Wind Turbine (HAWT);<br>• label the main components of a horizontal axis wind turbine;<br>• build a working model of a wind generator (HAWT);<br>• use the equation $\frac{1}{2} mv^2$ to calculate the energy available to a wind turbine at different wind speeds;<br>• define what is meant by the Betz Limit and explain how it is related to real world wind turbine power efficiencies;<br>• explain the terms ‘rotor collected energy’ and ‘rated energy output’ and detail the reasons for the energy shortfall between them;<br>• explain the relationship between power output and swept area;<br>• use the formula $\pi r^2$ to calculate the rotor swept area for different rotor diameters; and<br>• explain the relationship between wind speed and power production and interpret power curves/profiles for different wind speeds.</td></tr>
</table>

| Content | Learning Outcomes |
|---|---|
| **Energy from Wind (cont.)** | Students should be able to:<br>• demonstrate the effect of blade diameter on the power output of a wind generator;<br>• describe how the power output from a wind turbine is affected by air density, temperature and altitude;<br>• assess the factors that affect maximum energy production in wind turbines in the context of cost–benefit analysis;<br>• understand the terms hub height and rotor diameter and explain the critical factors used to determine hub height;<br>• explain that wind resource assessment, terrain, turbine size and visual impact are critical factors used to determine hub height;<br>• demonstrate that the mass of a turbine is approximately proportional to the cube of its blade length;<br>• describe how turbine performance is influenced by the blade length, strength of materials and siting requirements;<br>• define wind survival speed as the maximum wind speed that a turbine is designed to withstand before sustaining damage;<br>• understand that all wind turbines are designed with some element of power control;<br>• explain how yawing ensures that the turbine faces the oncoming wind;<br>• discuss how commercial wind farm ventures seek to optimise the location for their turbines by considering energy output, costs, environmental and social issues; |
| **Energy from the Sun** | • provide an approximation of the amount of solar energy available for UK energy purposes each year;<br>• describe the two approaches (solar thermal and PV) used in solar collectors; and<br>• explain how an automated tracking system can maximise energy output from solar collectors. |

| Content | Learning Outcomes |
|---|---|
| **Energy from the Sun (cont.)** | Students should be able to:<br>• demonstrate a practical understanding of the operation of flat plate and evacuated tube solar thermal collectors;<br>• calculate the amount of roof space typically required for a domestic flat plate solar thermal collector, taking the following issues into consideration:<br>– solar radiation levels;<br>– shading;<br>– collector type;<br>– family size; and<br>– lifestyle of users;<br>• evaluate the benefits to households of installing a flat plate solar thermal collector;<br>• build a working thermal solar cell;<br>• measure thermal output in differing climate conditions;<br>• describe the composition and structure of a PV cell and explain the role of the semiconductor wafer in producing electricity;<br>• identify the four material types of PV modules (monocrystalline, polycrystalline, thick-film and thin-film);<br>• use a PV panel to power a small voltage motor;<br>• monitor the motor output in differing levels of sunlight;<br>• evaluate the advantages and disadvantages of each type of PV panel, including cost, longevity and efficiency;<br>• explain how planning regulations can affect the installation of solar panels; and<br>• discuss the range of incentives available to homeowners considering installing solar panels, for example selling electricity to energy suppliers. |

| Content | Learning Outcomes |
| --- | --- |
| **Energy from the Sun (cont.)** | Students should be able to:<br>• describe how passive solar design techniques can be applied to new and existing buildings, referring to window placement, orientation, size and glazing type, thermal mass and thermal insulation;<br>• explain how Concentrating Solar Power (CSP) systems use lenses or mirrors to focus a large area of sunlight into a small beam for use in power plants, including parabolic troughs, dishes and Fresnel reflectors; |
| **Energy from Biomass** | • define the term biomass and give examples of categorised types:<br>– organic materials;<br>– wood;<br>– agricultural crops; and<br>– agricultural and municipal wastes;<br>• identify some of the main plant crops that are grown commercially to produce biomass, for example:<br>– willow;<br>– poplar;<br>– elephant grass;<br>– maize; and<br>– sugar cane;<br>• assess the advantages and disadvantages of using biomass as a fuel source;<br>• state that combustion accounts for over 90 percent of all energy obtained from biomass;<br>• grow seedlings under controlled and measurable light conditions and measure the energy released on combustion;<br>• compare and contrast the properties of different types of woodchip;<br>• outline the process of gasification as how biomass is converted into a mixture of carbon monoxide and hydrogen, commonly known as syngas (chemical reactions not required); and<br>• identify the principal uses of syngas as a fuel source. |

| Content | Learning Outcomes |
| --- | --- |
| **Energy from Biomass (cont.)** | Students should be able to:<br>• understand that biogas is primarily a mixture of methane and carbon dioxide, produced by the biological breakdown of organic matter in the absence of oxygen (anaerobic digestion);<br>• discuss the advantages and disadvantages of using commercial anaerobic digesters; |
| **Energy Storage** | • explain the problems associated with delivering energy from renewable energy sources, primarily:<br>– the reliability of wind, wave, solar and tidal; and<br>– the intermittency of wind, wave, solar and tidal;<br>• relate the problems outlined above to the need to develop energy storage facilities capable of storing energy produced from renewable sources;<br>• outline the basic operational systems involved in energy storage for both Compressed Air Energy Storage (CAES) and pumped hydro;<br>• discuss the types of locations where energy storage would be most beneficial as well as cost effective; |
| **The Development of Plastics for the Future** | • understand the significance of global reliance on crude oil as both a fuel source and an industrial feedstock;<br>• understand that global production of plastic continues to increase each year and that plastic production is the largest single user of crude oil outside the energy and transport sectors;<br>• explain that the gases formed by fractional distillation are cooled, liquefied and stored for use as feedstocks in the plastics industry;<br>• understand that the pollution problems associated with plastics fall into two main areas:<br>– polymers and plastics made from crude oil derivatives cannot be broken down by micro-organisms or easily recycled (for example the great Pacific garbage patch); and<br>– toxic gases, such as carbon monoxide, hydrogen cyanide and hydrochloric acid, are released by incinerating plastic materials. |

| Content | Learning Outcomes |
|---|---|
| **The Development of Plastics for the Future (cont.)** | Students should be able to:<br>• describe some of the uses of plastics that are designed to be either biodegrading or photodegrading, including agricultural films, packaging and labelling;<br><br>• compare the degradability of samples of photodegradable plastic and polythene using a propagator with ultraviolet (UV) bulbs;<br><br>• compare the tensile strength of photodegradable plastic and polythene, using a simple Newton meter;<br><br>• describe how modern plastic manufacturing processes can use the following options:<br>– incorporating additives into the polymer during the manufacturing process to enhance biodegradability;<br>– modifying the process to enhance thermal and photodegradation; and<br>– producing compostable plastics that can be used to improve soil composition in regions where soil structure is poor;<br><br>• describe the manufacture of bioderived polyethylene (BPE), a recyclable plastic (chemical equations not required); and<br><br>• assess the need for a global move towards the more sustainable manufacture and use of plastics. |

## 3.2 Unit AS 2: Internal Assessment – Renewable Energy Technologies

This unit gives students the opportunity to apply knowledge and understanding gained in AS 1 to a practical context. Students research renewable energy sources and evaluate the technical, environmental and economic aspects of the energy output from wind, solar and biomass.

Students submit a technical report that relates to a realistic scenario task. Following guidance outlined in the scenario task, students research the use of wind, solar and biomass technologies and then design and conduct a practical investigation into at least two of these technologies. They evaluate their research findings and provide a series of recommendations linked to the scenario task.

Students should present the technical report in three sections:

- desktop research;
- practical investigation; and
- discussion and recommendations.

Details of the requirements of each section are set out below. The learning outcomes describe what the student is expected to demonstrate in their technical report. You can find details on the suggested word limit for the technical report in Section 6.

| Skills Activity | Learning Outcomes |
|---|---|
| **Technical Report (Renewable Energy Technologies)**<br><br>Desktop Research | Students should be able to:<br>• demonstrate an understanding of the type of information required from desktop research;<br>• extract and summarise relevant information;<br>• analyse and critically evaluate information; and<br>• present their research findings in the format outlined below:<br>– **Title**: clearly identifying the focus of the technical report;<br>– **Introduction**: offering a rationale for the chosen focus of the desktop research, including a link to the scenario;<br>– **Research summary**: including a concise summary of the most significant pieces of information gathered from the desktop research;<br>– **Evaluation:** including an analysis and critical evaluation of the research findings as well as a comment on their relevance to the specific issues raised in the scenario; and<br>– **References**: including details of **all** sources of information. |

| Skills Activity | Learning Outcomes |
|---|---|
| Practical Investigation | Students should be able to:<br>• identify an appropriate investigation that will extend their knowledge and understanding of at least two of the three renewable energy technologies;<br>• work safely and record accurate and reliable observations and measurements;<br>• interpret their findings and present relevant data appropriately in written, tabular, graphical or other forms;<br>• evaluate the methodology used in the practical investigation;<br>• apply their knowledge and the findings from their research and practical investigation as the basis for their decision-making processes;<br>• draw up a series of recommendations for the use of renewable energy technologies, taking into consideration the specific features of the scenario task; and<br>• present their work in the format outlined below:<br>– **Introduction**: clearly identifying the focus of the primary research being undertaken;<br>– **Design**: including details of the apparatus to be used and reference to working safely and risk assessment;<br>– **Data collection**: including details of the measurements and/or observations to be taken, with reference to reliability and accuracy;<br>– **Presentation and analysis of data**: using a variety of methods, for example tables or graphs, and identifying trends and patterns;<br>– **Discussion**: drawing together the relevant findings from the desktop research and the practical investigation and explaining how they will use these to inform the decision-making part of the scenario task; and<br>– **Conclusions and recommendations**: demonstrating the application of knowledge and including reference to any trends and patterns identified from the data and presenting their recommendations. |

## 3.3 Unit A2 1: Building and Managing a Sustainable Future

As increased demand depletes the Earth's finite resources, there is a global imperative for its population to find more sustainable ways of living. This demands that we consider the environmental, social and economic impact of population growth and develop an integrated approach to problem solving.

This unit looks at a range of new and existing technologies and management systems that have the potential to support society's move toward a more sustainable way of living. Students examine waste management processes (including bioremediation) and using low-carbon sources for society's transport needs. They also investigate issues related to the environmental performance of buildings. Students explore the sustainable development needs of urban and rural communities and take account of health and safety practices when carrying out all practical work.

| Content | Learning Outcomes |
|---|---|
| **Sustainability and Future Development** | Students should be able to:<br>• understand how the increasing world population affects demand for the Earth's resources (fuel, water, food and shelter);<br>• debate the role of technology in meeting global requirements in the context of the relationship:<br>I = PAT (I = impact, P = population, A = affluence,<br>T = damage caused by technology)<br>in comparing environmental impacts;<br>• define and explain the concept and measurement of an ecological footprint for individuals and nations and the link between an ecological footprint and a carbon footprint;<br>• understand the concept of One Planet Living (OPL); |
| **Waste Management** | • discuss Northern Ireland's over-reliance on landfill and the difficulties associated with locating and developing new landfill sites;<br>• list the major waste types and the priority waste streams identified in the Northern Ireland Waste Management Strategy; and<br>• describe how the key EU strategies and directives identified in the Northern Ireland Waste Management Strategy are driving improvements in waste management practice in Northern Ireland. |

<table>
<tr><th>Content</th><th>Learning Outcomes</th></tr>
<tr><td>Waste Management (cont.)</td><td>Students should be able to:<ul><li>explain the term ‘waste management hierarchy’ with reference to prevention, reduce, reuse, recycle, energy recovery and disposal;</li><li>outline the main processes associated with waste recycling at a Materials Recovery Facility (MRF) for common domestic waste items such as glass, aluminium, paper and plastics;</li><li>explain the process by which waste in landfill breaks down over time and identify the factors that influence the rate at which methane and leachate are produced;</li><li>demonstrate how modern engineered landfill sites are designed to address the problems of methane and leachate production, using the terms ‘dry tomb’ and ‘bioreactor’;</li><li>explain how the landfill tax encourages a reduction in levels of landfill as well as supporting environmental initiatives;</li></ul></td></tr>
<tr><td>Waste to Energy Technologies</td><td><ul><li>describe the concept of embodied energy;</li><li>discuss the advantages and disadvantages of recovering energy from waste (incineration);</li><li>outline key terms associated with anaerobic digestion:<br>– low and high solids;<br>– residence time;<br>– single; and<br>– multistage;</li><li>explain the stages associated with anaerobic digestion:<br>– mechanical pretreatment;<br>– hydrolysis;<br>– acidogenesis;<br>– acetogenesis; and<br>– methanogenesis (chemical equations not required);</li><li>outline how anaerobic digestion can deliver both heat and power (CHP); and</li><li>identify the types of waste that can be treated by composting.</li></ul></td></tr>
</table>

| Content | Learning Outcomes |
|---|---|
| **Waste to Energy Technologies (cont.)** | Students should be able to:<br>• explain why composting is unsuitable for treating any form of catering waste; |
| **Risk Management of Land Contamination** | • explain bioremediation as a method of using micro-organisms to treat contaminated land, for example a brownfield site with waste oil, heavy metals, chlorinated pesticides, polychlorinated biphenyls (PCBs) and diesel oil; |
| Bioremediation | • identify a range of named micro-organisms and the pollutants they treat:<br>– *Pseudomonas putida* to treat organic solvents;<br>– *Pseudomonas aeruginosa* to treat oil; and<br>– *Dehalococcoides ethenogenes* to treat halogenated hydrocarbons;<br><br>• discuss the economic and environmental benefits of using bioremediation technology compared to traditional treatment methods;<br><br>• outline the role of, and the issues arising from, using genetic engineering to modify micro-organisms used in bioremediation to further enhance the scope of the technology;<br><br>• explain the use of in situ bioreactor systems to treat small to medium scale amounts of contaminated soil; and |
| Phytoremediation | • describe how plants can be used to decontaminate industrial pollution of soil and remove:<br>– copper;<br>– cadmium;<br>– strontium;<br>– rubidium;<br>– arsenic; and<br>– antimony. |

| Content | Learning Outcomes |
| --- | --- |
| Phytoremediation (cont.) | Students should be able to:<br>• discuss the advantages and limitations of using alpine pennygrass and Indian mustard in the commercial decontamination of soil contaminated with the following metal ions:<br>– cadmium;<br>– zinc;<br>– copper;<br>– lead;<br>– gold; and<br>– uranium; |
| Phytoextraction | • describe how plant species can be used as an alternative method to extract metal from metal ore mine tailings by the process of phytoextraction, for example using white mustard to extract copper or sunflower to extract gold;<br>• demonstrate the use of Indian mustard in decontaminating metal contaminated soil; |
| Biohydrometallurgy (Biorefining) | • define biohydrometallurgy as using bacteria to extract metals from low grade ore;<br>• understand that traditional metal smelting technologies are energy intensive and highly polluting;<br>• identify *Thiobacillus ferrooxidans* as bacteria capable of refining copper, zinc, lead and uranium;<br>• describe how suitable sites are identified and prepared for biorefining; and<br>• discuss advantages and disadvantages of biorefining in relation to traditional metal extraction methods. |

<table>
<tr><th>Content</th><th>Learning Outcomes</th></tr>
<tr><td>Hydrogen Fuel Cell Opportunities</td><td>Students should be able to:
<ul>
<li>explore the key points of hydrogen chemistry with particular emphasis on those properties that relate to its extraction and use as a fuel, including reactivity and density;</li>
<li>outline the bulk production of hydrogen by the following methods:<br>– steam reforming of fossil gases;<br>– electrolysis of water; and<br>– photocatalytic water splitting<br>(to include simple equations only);</li>
<li>describe the process of energy conversion that occurs in the most common forms of hydrogen fuel cells:<br>– Polymer Electrolyte Membrane (PEM);<br>– alkaline;<br>– phosphoric acid;<br>– molten carbonate; and<br>– solid oxide<br>(to include redox reactions involved);</li>
<li>demonstrate the operation of a fuel cell, using a scale model;</li>
<li>demonstrate an understanding of a range of applications of hydrogen fuel cells to include:<br>– stationary generation as back up or in remote locations;<br>– stand-alone power supplies for telecommunications installations; and<br>– transport, including cars, buses, trains, boats or portable power generators;</li>
<li>discuss the challenges presented by using hydrogen as an energy source, for example production costs, transport issues and safe storage; and</li>
</ul></td></tr>
<tr><td>Transport System Challenges</td><td><ul>
<li>outline the four key challenges of developing a way to transport people and goods in the future:<br>– economic viability;<br>– environmental impacts;<br>– dependence on fossil fuels; and<br>– user safety.</li>
</ul></td></tr>
</table>

| Content | Learning Outcomes |
| --- | --- |
| **Transport System Challenges (cont.)** | Students should be able to:<br>• understand the role of new vehicle (public and private) technologies including:<br>– hydrogen-fuelled vehicles;<br>– biofuelled vehicles; and<br>– electric and hybrid vehicles;<br><br>• describe the physical infrastructures required for each of the technologies to function effectively;<br><br>• demonstrate an understanding of the basic steps in the industrial production of bioethanol from biomass, including chemical equations for fermentation and esterification;<br><br>• produce bioethanol in a laboratory;<br><br>• describe the main stages in the manufacture of biodiesel from vegetable oils using methanol and sodium hydroxide;<br><br>• measure the heat energy of ethanol;<br><br>• explain the advantages and disadvantages of using biodiesel as a substitute fuel;<br><br>• understand why the increasing global production of biofuels is contentious, taking into account the following issues:<br>– environmental impact of farming energy crops intensively, for example palm oil;<br>– designation of land away from food production into cash energy crops, particularly in the developing world; and<br>– destruction of natural habitats;<br><br>• assess the effectiveness of different strategies to reduce transport demand, including public transport, sustainable modes of transport (walking or cycling), fuel and vehicle taxation, congestion charging, air travel levies and use of technology, for example videoconferencing or apps to reduce congestion; and |
| **Energy Building Performance** | • explain the economic and environmental benefits of energy conservation in the home and indicate the role of residents' behaviour in minimising energy consumption. |

| Content | Learning Outcomes |
|---|---|
| **Energy Building Performance (cont.)** | Students should be able to:<br>• describe how the following factors influence the energy efficiency of a building:<br>– insulation;<br>– air tightness; and<br>– glazing;<br><br>• define what is meant by 'U value' and understand that different construction materials have different U values;<br><br>• recall, understand and use the equation:<br><br>rate of heat flow = U value × area × temperature difference;<br><br>• explain the concept of zero carbon homes hierarchy and demonstrate how it can be applied to new buildings;<br><br>• show an understanding of the principal environmental building performance measurement system for zero carbon buildings: BREEAM (Building Research Establishment Environmental Assessment Method);<br><br>• demonstrate an understanding of the Code for Sustainable Homes (CSH);<br><br>• discuss the challenge of the UK government's policy to improve the environmental performance of existing housing stock through the CSH; |
| **Emerging Technologies**<br><br>Wave and Tidal | • discuss why producing energy from waves and tides is a priority concern for Northern Ireland;<br><br>• identify the constraints on developing wave and tidal technology, for example limited availability of suitable sites and high cost of development; and<br><br>• compare and contrast the two major generating methods for tidal power:<br>– tidal stream generators, for example SeaGen, Strangford Lough; and<br>– tidal barrage, for example Rance Estuary, France. |

| **Content** | **Learning Outcomes** |
|---|---|
| Wave and Tidal (cont.) | Students should be able to:<br>• outline the operational processes in two main types of wave energy converters: point absorber and attenuator, for example Pelamis;<br>• describe the environmental impact of tidal and wave energy devices, with reference to marine life and habitat, toxic pollution, visual and noise impact and conflict with other sea users; |
| Smart Materials | • define what is meant by a smart material;<br>• explain how smart materials can be used to support environmental management, for example smart glass; |
| Smart Systems | • explain what is meant by a smart system;<br>• describe the range of applications offered by a smart system with reference to engineering, transportation and waste management;<br>• discuss the potential environmental and economic benefits offered by the use of smart systems; |
| Carbon Capture and Storage (CCS) | • explain what is meant by carbon capture and its potential for reducing carbon dioxide emissions from fossil fuel power plants;<br>• discuss the three phases identified in the carbon capture process: trapping and separating, transport, and storage (underground and underwater); |
| Geo-Engineering | • debate the advantages and risks associated with geo-engineering as the deliberate modification of the Earth's atmosphere to offset the effects of climate change; and |
| Bio-Photovoltaics | • describe the use of green algae to generate electricity in biological solar cells. |

| **Content** | **Learning Outcomes** |
|---|---|
| **The Development of Urban and Rural Sustainable Communities** | Students should be able to:<br>• discuss, using appropriate examples, the main characteristics of an urban development that links sustainability, zero carbon concepts and the role of technology, including:<br>– reduced energy use for both heating and cooling;<br>– microgeneration in urban areas and the use of smart grid technology;<br>– lower cost and more comfortable and versatile buildings;<br>– integrated and flexible transport facilities;<br>– planned waste management systems that deal with the waste source;<br>– the reuse of brownfield sites;<br>– systems to deal with water shortage;<br>– sustainable urban drainage schemes;<br>– using green spaces to moderate the urban heat island;<br>– using green spaces that work for people and wildlife, for example food production in urban areas; and<br><br>• discuss the issues that underpin the development of sustainable rural communities:<br>– cost and environmental impacts of linking isolated dwellings to water, waste water, energy supply, communication and transport networks;<br>– application of independent energy solutions using indigenous energy sources, for example biomass, agricultural waste treatment, wind power and small-scale district heating solutions;<br>– potential for use of local water sources;<br>– use of small-scale waste water treatment solutions (provision and operation of septic tanks);<br>– benefits of local food production and consumption from environmental, economic and social perspectives; and<br>– impact of communication technologies in improving accessibility to rural areas without generating new travel demands. |

## 3.4 Unit A2 2: Internal Assessment – Environmental Building Performance and Measurement

Unit A2 2 gives students the opportunity to apply the knowledge and understanding gained in A2 1 to a practical context. Students consider the sustainability performance of a building and apply the Code for Sustainable Homes (CSH) system to a specific construction. Students gather a range of data, both qualitative and quantitative, and analyse it in order to create a performance profile for their chosen building. Students also write a commentary on how this performance could be enhanced. The commentary is assessed through each student's evaluation of the processes involved. Students must produce a technical report that demonstrates their understanding and ability to apply a range of categories from the CSH framework.

To complete the task, candidates must be familiar with the nine key elements of the CSH.

You can find details of the suggested word limit for the technical report in Section 6 of this specification.

| Skills Activity | Learning Outcomes |
|---|---|
| **Technical Report** | Students should be able to:<br>• demonstrate an understanding of the CSH in a real life scenario;<br>• apply the processes identified in the CSH to a local building they have chosen;<br>• work safely and obtain relevant data for selected elements of the CSH; and<br>• analyse and critically evaluate data. |

| Skills Activity | Learning Outcomes |
|---|---|
| **Technical Report (cont.)** | Students should be able to:<br>• present their findings in the format outlined below:<br>– **Title**: clearly identifying the focus of the investigation;<br>– **Introduction**: a rationale, including the policy context that promotes environmental building performance, clearly stating the purpose and focus of the investigation and referring to the CSH and its elements;<br>– **Building Assessment**: including details of data collection and analysis and a commentary on health and safety in tabular and graphical forms, using diagrams, pictures and schematics to enhance the technical report;<br>– **CSH Performance**: containing a summary of how the CSH credits have been accumulated, the CSH rating and an overall commentary on the performance of the building;<br>– **Discussion**: including an evaluation of the measurement processes involved in applying the CSH criteria along with a series of recommendations for enhancements to the building in order to improve its rating;<br>– **Evaluation**: offering a short assessment of sustainability measurement processes; and<br>– **References**: including details of **all** sources of secondary data. |

# 4 Scheme of Assessment

## 4.1 Assessment opportunities

For the availability of assessment units, see Section 2 of this specification.

It is possible to resit individual AS and A2 assessment units once. The best result for each assessment unit counts towards the AS and A Level qualifications. Results for individual assessment units remain available to count towards an AS or A Level qualification until we withdraw the specification.

## 4.2 Assessment objectives

Candidates should be able to demonstrate:

- knowledge and understanding of environmental technology (AO1);
- the application of skills, knowledge and understanding through different contexts associated with environmental technology (AO2); and
- the ability to investigate, analyse, evaluate, make reasoned judgements and communicate findings about issues in environmental technology (AO3).

## 4.3 Assessment objective weightings

The table below sets out the assessment objective weightings for each assessment unit and the overall AS and A Level qualifications:

| **AO Weightings** | | | | | |
|---|---|---|---|---|---|
| | AO1 | AO2 | AO3 | AS | A level |
| **AS1** | 7.2% | 7.2% | 5.6% | 20% | 20% |
| **AS2** | 5.6% | 7.2% | 7.2% | 20% | 20% |
| **A21** | 8.4% | 10.8% | 10.8% | | 30% |
| **A22** | 7.2% | 12.0% | 10.8% | | 30% |
| **Total** | **28.4%** | **37.2%** | **34.4%** | **40%** | **100%** |

## 4.4 Quality of written communication

In AS and A Level Environmental Technology, candidates must demonstrate their quality of written communication. 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 and tasks that require extended writing.

## 4.5 Synoptic assessment at A2

The A2 assessment units include an element of synoptic assessment, which encourages the development of the understanding of the subject as a whole. In Environmental Technology synoptic assessment requires candidates to demonstrate that they can:

- build on material first encountered in the AS units;
- gather the knowledge, understanding and skills learned in different parts of the A Level course;
- select and present work for examination that demonstrates their strengths across the areas of knowledge and the range of skills described;
- sustain their own lines of enquiry and record and observe from primary sources;
- bring together and make connections between the areas of knowledge and the range of skills described and learned throughout the course; and
- respond to a problem or issue.

## 4.6 Stretch and challenge at A2

The A2 assessment units provide opportunities for stretch and challenge by incorporating:

- a wide range of question types to address different skills, for example scenario tasks and open-ended questions;
- a high number of greater demand evaluative tasks;
- questions that require candidates to show more connections between sections of the specification; and
- extended writing where appropriate.

## 4.7 Reporting and grading

We report the results of individual assessment units on a uniform mark scale that reflects the assessment weighting of each unit.

We award AS qualifications on a five grade scale from A to E, with A being the highest. We award A Level qualifications on a six grade scale from A* to E, with A* being the highest. We determine the AS and A Level grades awarded by aggregating the uniform marks obtained on individual assessment units. To be awarded an A*, candidates need to achieve a grade A on their full A Level qualification and at least 90 percent of the maximum uniform marks across the A2 units. If candidates fail to attain a grade E, we report their results as unclassified (U).

The grades we award match the grade descriptions in Section 5 of this specification.

# 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.

### AS Grade Descriptions

| Grade | Description |
|---|---|
| **AS**<br><br>**A Grade Boundary** | For **AO1**, candidates characteristically:<br>• demonstrate detailed knowledge and understanding of a range of concepts and processes from the AS specification;<br>• demonstrate detailed knowledge and understanding of subject-specific material; and<br>• select, organise and present information in a variety of forms using scientific terminology. |
| | For **AO2**, candidates characteristically:<br>• demonstrate understanding of the working characteristics and potential application of a range of renewable energy technologies;<br>• apply skills, knowledge and understanding of processes, techniques and equipment to design an appropriate scientific investigation;<br>• research and communicate a range of ideas and possible solutions in an effective manner;<br>• describe significant trends and patterns shown by data presented in tabular or graphical form;<br>• explain and interpret phenomena with few errors and present arguments and evaluations clearly;<br>• apply principles and concepts in familiar and new contexts involving some steps in the argument; and<br>• carry out structured calculations with few errors and demonstrate good understanding of the underlying relationships between physical quantities. |

| Grade | Description |
|---|---|
| | For **AO3**, candidates characteristically:<br>• analyse and offer a valid evaluation of environmental information, issues and viewpoints;<br>• demonstrate safe and skilful practical techniques;<br>• make observations with appropriate precision and record these methodically;<br>• interpret, explain, evaluate and communicate the results of their own experimental and investigative activities in appropriate contexts; and<br>• reach valid conclusions and communicate findings clearly in a structured manner appropriate to the task. |
| **AS**<br>**E Grade Boundary** | For **AO1**, candidates characteristically:<br>• demonstrate some knowledge and understanding of some concepts and processes;<br>• show basic knowledge and understanding of subject-specific material with significant omissions; and<br>• demonstrate some organisational skills and present information using basic terminology. |
| | For **AO2**, candidates characteristically:<br>• demonstrate some understanding of the working characteristics and application of a limited range of renewable energy technologies;<br>• apply skills, knowledge and understanding of process, techniques and equipment to devise and plan some aspects of a scientific investigation;<br>• research and communicate ideas appropriately;<br>• describe some trends or patterns shown by data presented in tabular or graphical form;<br>• provide basic explanations and interpretations of some phenomena, presenting very limited evaluations;<br>• apply a given principle to material presented in familiar or closely related contexts involving only a few steps in the argument; and<br>• carry out some steps within calculations. |

| Grade | Description |
| --- | --- |
| | For **AO3**, candidates characteristically:<br>• offer some limited evaluation of environmental information, issues and viewpoints;<br>• demonstrate safe practical techniques;<br>• make observations and measurements and record them;<br>• interpret, explain and communicate some aspects of the results of their own experimental and investigative activities in appropriate contexts; and<br>• draw some limited conclusions and communicate findings. |

**A2 Grade Descriptions**

| Grade | Description |
| --- | --- |
| **A2**<br>**A Grade Boundary** | For **AO1**, candidates characteristically:<br>• demonstrate thorough knowledge and understanding of a wide range of concepts and processes from the A2 specification;<br>• show thorough knowledge and understanding of subject-specific material; and<br>• select, organise and present information clearly in appropriate forms using scientific terminology. |
| | For **AO2**, candidates characteristically:<br>• demonstrate thorough understanding of the working characteristics and potential application of a range of environmental management systems;<br>• apply skills, knowledge and understanding of processes, techniques and equipment to assess environmental building performance;<br>• research and communicate a broad range of ideas and possible solutions in a creative and innovative way;<br>• describe significant trends and patterns shown by complex data presented in tabular or graphical form;<br>• explain and interpret phenomena with few errors and present arguments and evaluations clearly and logically;<br>• apply principles and concepts in familiar and new contexts involving several steps in the argument;<br>• carry out structured calculations with little or no guidance and demonstrate good understanding of the underlying relationships between physical quantities; and<br>• link together appropriate facts, principles and concepts from different areas of the specification. |

| Grade | Description |
|---|---|
| | For **AO3**, candidates characteristically:<br>• accurately and competently analyse and interpret environmental information, issues and viewpoints;<br>• demonstrate safe and skilful practical techniques;<br>• make observations with appropriate precision and record these methodically;<br>• interpret, explain, evaluate and communicate the results of their own experimental and investigative activities in appropriate contexts; and<br>• reach substantiated and valid conclusions and communicate findings accurately and appropriately to the task. |
| **A2**<br>**E Grade Boundary** | For **AO1**, candidates characteristically:<br>• demonstrate some knowledge and understanding of the main concepts and processes from the A2 specification;<br>• show some knowledge and understanding of subject-specific material with significant omissions; and<br>• select, organise and present information using basic scientific terminology. |
| | For **AO2**, candidates characteristically:<br>• demonstrate some understanding of the working characteristics and potential application of a range of environmental management systems;<br>• apply skills, knowledge and understanding of processes, techniques and equipment to assess some aspects of environmental building performance;<br>• research and communicate some ideas and possible solutions in an appropriate manner;<br>• describe and provide a limited explanation of trends or patterns shown by complex data presented in tabular or graphical form;<br>• provide basic explanations and interpretations of some phenomena, presenting very limited arguments and evaluations;<br>• apply given principles or concepts in familiar and new contexts involving some steps in the argument;<br>• carry out routine calculations where help is given; and<br>• collate some facts, principles and concepts from different areas of the specification. |

| Grade | Description |
|---|---|
| | For **AO3**, candidates characteristically:<br>• show some attempts to analyse and interpret environmental information, issues and viewpoints with varying degrees of success;<br>• demonstrate safe practical techniques;<br>• make observations and measurements and record them;<br>• interpret, explain and communicate some aspects of their own experimental and investigative activities in appropriate contexts; and<br>• draw some straightforward conclusions and communicate findings broadly appropriate to the task. |

# 6 Guidance on Internal Assessment

There are two internal assessments in this specification, one at AS Level and one at A2:

- Internal Assessment Unit AS 2: Renewable Energy Technologies; and
- Internal Assessment Unit A2 2: Environmental Building Performance and Measurement.

The internal assessments will have a specific focus on candidates' ability to apply their knowledge and skills in a work-related context.

## 6.1 Setting of tasks

We will provide centres with details of the internal assessment tasks and guidance on how to complete and submit them. Teachers must ensure that the completed tasks conform to the unit requirements.

For **AS 2** we will issue a scenario and task in September 2016 for first submission in summer 2017. Each year we will issue a new scenario and task to ensure that they continue to set an appropriate challenge and remain valid, reliable and stimulating.

For **A2 2** we will issue a scenario and task in September 2017 for first submission in summer 2018. Each year we will issue a new task, which will focus on two different categories within the Code for Sustainable Homes (CSH), to ensure that the tasks continue to set an appropriate challenge and remain valid, reliable and stimulating.

## 6.2 Supervision of candidates

Candidates should work independently when completing their internal assessment tasks. Teachers must be able to authenticate the work. Teachers must guide and supervise the candidates in relation to the following:

- monitoring progress;
- preventing plagiarism;
- ensuring compliance with health and safety requirements; and
- ensuring work is completed in accordance with the specification's requirements.

Teachers must sign a declaration to certify that, to the best of their knowledge, all the work the candidate has submitted for assessment is their own. Teachers must be aware of third party copyright issues.

For up-to-date advice on plagiarism, or any kind of candidate malpractice, teachers should 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

## 6.3 Word limit

Each report should be a maximum of **4000 words**.

In AS 2 Renewable Energy Technologies:

- The introduction should not exceed **500 words**.
- The desktop research should not exceed **1000 words**.
- The practical investigation should not exceed **1000 words**.
- The discussions and recommendations should be a maximum of **1500 words**.

In A2 2 Environmental Building Performance and Measurement:

- The scene setting should not exceed **500 words**.
- The primary investigations should not exceed **1500 words**.
- The recommendations, including the commentary on the sustainability measurement processes used throughout the task, and the evaluation should be a maximum of **2000 words**.

## 6.4 Collaboration

The work of individual candidates may be informed by working with others, but each candidate must provide an individual response.

## 6.5 Marking and internal standardisation

Teachers should use their professional judgement to select and apply the criteria in each mark band appropriately and fairly to candidates' work. They should award the appropriate mark within any range on a 'best fit' basis, making allowance for balancing strengths and weaknesses within each response.

The assessment criteria and mark bands for units AS 2 and A2 2 are in Appendix 1.

Centres with more than one teaching group must carry out internal standardisation of the internal assessment tasks before submitting them to us. This is to ensure, as far as possible, that each teacher has applied the assessment criteria consistently when marking assessments.

After internal standardisation, it may be necessary to adjust an individual teacher's marking. This is to bring assessments into line with those of other teachers in the centre and to match the standards established at the agreement trial. Where adjustment is necessary, the total/final mark recorded on the Candidate Record Sheet should be amended.

## 6.6 Moderation

Centres must submit their marks and samples to us by the notified date 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 marks and samples must be submitted to us.

Teachers and centre staff may contact us at any stage if they require advice, assistance or support regarding any aspect of internal assessment. We provide moderators who can support groups of centres or contact individual centres to discuss issues arising from the internal assessments.

# 7 Links

## 7.1 Support

We provide the following resources to support this specification:

- a subject microsite within our website;
- guidance notes for teachers; and
- specimen assessment materials.

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

- past papers;
- Chief Examiner's reports;
- Principal Moderator's reports;
- schemes of work;
- centre support visits;
- support days for teachers;
- technical report clinics;
- agreement trials;
- a resource list; and
- exemplification of standards.

## 7.2 Curriculum objectives

This specification addresses and builds upon the broad curriculum objectives for Northern Ireland. In particular, it allows students to develop an understanding of:

- moral, ethical, social, economic, cultural and legislative issues, for example:
  - the global economic, environmental and social implications of the worldwide reliance on fossil fuels as a source of energy;
  - the global imperative to reduce reliance on fossil fuels through conserving supplies and increased use of renewable energy technologies; and
  - national and international targets for renewable sources of energy and energy conservation;
  - sustainable development and environmental concerns; the specification is founded on the principles of sustainable development and focuses on the use of existing and emerging technologies to address environmental issues on a global and local level;
- health and safety issues, for example throughout practical work students must pay particular attention to safe working practices; and
- the 'skills agenda' and employability, for example students will develop skills and attributes that will enhance their employability, for example communication, numeracy, the ability to think logically and rationally, decision making, problem solving, ICT skills and teamwork.

## 7.3 Skills development

This specification provides students with opportunities to develop the following key skills:

- application of number, for example measuring, scientific calculations, costings and data analysis;
- communication, for example communicating intentions and ideas in a range of formats, including written, visual, tabular and diagrammatic;
- improving own learning and performance, for example producing a technical report, researching, reviewing, analysing and evaluating work;
- information and communication technology, for example learning about new technologies and web-based research;
- problem solving, for example planning a scientific investigation with application to a real life scenario;
- decision making, for example researching and analysing information and data linked to informed decision making and producing recommendations; and
- working with others, for example in groups, liaising with employers, voluntary organisations or regulatory bodies.

## 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 equality legislation in developing this specification.

GCE 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.

During the development process, an external equality panel reviewed the specification to identify any potential barriers to equality and inclusion. Where appropriate, we have considered measures to support access and mitigate barriers.

Reasonable adjustments are made for students with disabilities. For this reason very few students, if any, should have difficulty accessing the assessment. Students with speech and/or learning impairments may need access to a sign language interpreter to complete the assessment task.

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 Reasonable Adjustments General and Vocational Qualifications*, available at www.jcq.org.uk

## 7.6 Contact details

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

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

- Officer with Subject Responsibility: Judith Ryan
  (telephone: (028) 9026 1200, email: jryan@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
  (telephone: (028) 9026 1401, 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 (Complaints and Appeals Manager: Marisa Getgood)
  (telephone: (028) 9026 1244, email: complaints@ccea.org.uk)

- Moderation
  (telephone: (028) 90261200, extension 2236, email: moderationteam@ccea.org.uk)

# Appendix 1

## Assessment Criteria and Mark Bands for Unit AS 2: Renewable Energy Technologies

| Assessment Objectives | Mark Band 1: Basic | Mark Range | Mark Band 2: Satisfactory | Mark Range | Mark Band 3: Good | Mark Range | Mark Band 4: Excellent | Mark Range |
|---|---|---|---|---|---|---|---|---|
| | Relevant material is poorly organised and presented with a lack of clarity and coherence. | | Relevant material is sufficiently organised and presented with some clarity and coherence. | | Relevant material is well organised and presented with a good degree of clarity and coherence. | | Relevant material is succinct, well organised and presented with a high degree of clarity and coherence. | |
| **AO1**<br>**Total: [14]** | Candidates may require considerable guidance and support to:<br>• produce a technical report that demonstrates a basic understanding of relevant concepts and context of different types of energy systems;<br>• demonstrate basic research skills and produce a research summary of at least two renewable energy technologies that lacks focus and structure;<br>• use basic written communication and specialist vocabulary; and<br>• identify reference material with limited appropriateness and accuracy. | [1–3] | Candidates may require some guidance to:<br>• produce a technical report that demonstrates a satisfactory understanding of relevant concepts and context of different types of energy systems;<br>• demonstrate adequate research skills and produce a research summary of at least two renewable energy technologies that shows some evidence of focus and structure;<br>• use satisfactory written communication and specialist vocabulary; and<br>• identify some reference material appropriately and accurately. | [4–6] | Candidates may require little guidance to:<br>• produce a technical report that demonstrates a good understanding of relevant concepts and context of different types of energy systems;<br>• demonstrate good research skills and produce a research summary of at least two renewable energy technologies that shows good evidence of focus and structure;<br>• use good written communication and specialist vocabulary; and<br>• identify most reference material accurately and appropriately. | [7–10] | Candidates work independently to:<br>• produce a technical report that demonstrates an extensive understanding of relevant concepts and context of different types of energy systems;<br>• demonstrate thorough research skills and produce a research summary of at least two renewable energy technologies that shows strong evidence of focus and structure;<br>• use excellent written communication and specialist vocabulary; and<br>• identify all reference material accurately and appropriately. | [11–14] |
| **Award zero for work not worthy of credit.** | | | | | | | | |

## Assessment Criteria and Mark Bands for Unit AS 2: Renewable Energy Technologies

| Assessment Objectives | Mark Band 1: Basic<br><br>Relevant material is poorly organised and presented with a lack of clarity and coherence. | Mark Range | Mark Band 2: Satisfactory<br><br>Relevant material is sufficiently organised and presented with some clarity and coherence. | Mark Range | Mark Band 3: Good<br><br>Relevant material is well organised and presented with a good degree of clarity and coherence. | Mark Range | Mark Band 4: Excellent<br><br>Relevant material is succinct, well organised and presented with a high degree of clarity and coherence. | Mark Range |
|---|---|---|---|---|---|---|---|---|
| **AO2**<br><br>**Total: [18]** | Candidates may require considerable guidance and support to:<br>• demonstrate a basic awareness of the design implications presented by the scenario task;<br>• provide a basic rationale for the choice of investigation that is supported by limited research;<br>• produce a basic design for the investigation; and<br>• produce simple calculations (possibly with errors) to support final recommendations. | [1–4] | Candidates may require some guidance to:<br>• demonstrate a satisfactory awareness of the design implications presented by the scenario task;<br>• provide a satisfactory rationale for the choice of investigation that is supported by satisfactory research;<br>• produce a satisfactory design for the investigation; and<br>• produce satisfactory calculations (possibly with minor errors) to support final recommendations. | [5–8] | Candidates may require little guidance to:<br>• demonstrate a broad awareness of the design implications presented by the scenario task;<br>• provide a clear rationale for the choice of investigation that is supported by good research;<br>• produce a good design for the investigation; and<br>• produce clear and accurate calculations to support final recommendations. | [9–13] | Candidates work independently to:<br>• demonstrate an extensive awareness of the design implications presented by the scenario task;<br>• provide a strong rationale for the choice of investigation that is supported by extensive research;<br>• produce a detailed and comprehensive design for the investigation; and<br>• produce comprehensive and accurate calculations to support final recommendations. | [14–18] |
| **Award zero for work not worthy of credit.** | | | | | | | | |

## Assessment Criteria and Mark Bands for AS 2: Renewable Energy Technologies

| Assessment Objectives | **Mark Band 1: Basic**<br><br>Relevant material is poorly organised and presented with a lack of clarity and coherence. | **Mark Range** | **Mark Band 2: Satisfactory**<br><br>Relevant material is sufficiently organised and presented with some clarity and coherence. | **Mark Range** | **Mark Band 3: Good**<br><br>Relevant material is well organised and presented with a good degree of clarity and coherence. | **Mark Range** | **Mark Band 4: Excellent**<br><br>Relevant material is succinct, well organised and presented with a high degree of clarity and coherence. | **Mark Range** |
|---|---|---|---|---|---|---|---|---|
| **AO3**<br><br>**Total: [18]** | Candidates may require considerable guidance and support to:<br>• carry out some parts of the investigation and obtain a basic number of measurements that may contain errors;<br>• record a basic range of data in a given table and show limited evidence of any interpretation and analysis;<br>• include reference to one risk;<br>• provide a simple discussion that may not make reference to the issues highlighted in the scenario task; and<br>• produce some simple recommendations that may not be supported by findings from the research summary and practical investigations. | [1–4] | Candidates may require some guidance to:<br>• carry out most parts of the investigation and obtain a satisfactory number of measurements that may contain errors;<br>• record a range of data in a table they devised with some evidence of interpretation and analysis;<br>• include reference to number of risks;<br>• provide an adequate discussion that makes some reference to the issues highlighted in the scenario task; and<br>• produce a list of recommendations that are supported by findings from the research summary and practical investigations; | [5–8] | Candidates may require little guidance to:<br>• carry out all parts of the investigation and obtain a complete set of measurements, using appropriate precision;<br>• record data in at least two different formats they devised and show evidence of meaningful interpretation and analysis;<br>• include a number of risks appropriate to the investigation and suggest how to minimise these;<br>• provide a good discussion that makes clear reference to the issues highlighted in the scenario task; and<br>• produce a list of relevant recommendations that are clearly supported by findings from the research summary and practical investigations. | [9–13] | Candidates work independently to:<br>• carry out all parts of the investigation and obtain a complete set of accurate measurements, using high level technical skills;<br>• record data in a range of different formats they devised and show evidence of clear and meaningful interpretation and analysis;<br>• include all risks associated with the investigation and suggest ways to minimise these;<br>• provide an extensive discussion that makes clear and strong reference to the issues highlighted in the scenario task; and<br>• produce a list of comprehensive recommendations that are strongly supported by findings from the research summary and practical investigations. | [14–18] |

## Assessment Criteria and mark bands for AS 2: Renewable Energy Technologies (cont.)

| Assessment Objectives | **Mark Band 1: Basic**<br><br>Relevant material is poorly organised and presented with a lack of clarity and coherence. | **Mark Range** | **Mark Band 2: Satisfactory**<br><br>Relevant material is sufficiently organised and presented with some clarity and coherence. | **Mark Range** | **Mark Band 3: Good**<br><br>Relevant material is well organised and presented with a good degree of clarity and coherence. | **Mark Range** | **Mark Band 4: Excellent**<br><br>Relevant material is succinct, well organised and presented with a high degree of clarity and coherence. | **Mark Range** |
|---|---|---|---|---|---|---|---|---|
| | Candidates may require considerable guidance and support to:<br>• provide a basic research evaluation that makes limited reference to the issues highlighted in the scenario task. | [1–4] | Candidates may require some guidance to:<br>• provide a satisfactory research evaluation that makes adequate reference to the issues highlighted in the scenario task. | [5–8] | Candidates may require little guidance to:<br>• provide a good research evaluation that makes clear reference to the issues highlighted in the scenario task. | [9–13] | Candidates work independently to:<br>• provide a comprehensive research evaluation that makes strong reference to the issues highlighted in the scenario task. | [14–18] |
| **Award zero for work not worthy of credit.** | | | | | | | | |

## Assessment Criteria and Mark Bands for A2 2: Environmental Building Performance and Measurement

| Assessment Objectives | **Mark Band 1: Basic**<br><br>Relevant material is poorly organised and presented with a lack of clarity and coherence. | **Mark Range** | **Mark Band 2: Satisfactory**<br><br>Relevant material is sufficiently organised and presented with some clarity and coherence. | **Mark Range** | **Mark Band 3: Good**<br><br>Relevant material is well organised and presented with a good degree of clarity and coherence. | **Mark Range** | **Mark Band 4: Excellent**<br><br>Relevant material is succinct, well organised and presented with a high degree of clarity and coherence. | **Mark Range** |
|---|---|---|---|---|---|---|---|---|
| **AO1**<br><br>**Total: [12]** | Candidates may require considerable guidance and support to:<br>• produce a technical report that demonstrates a basic understanding of CSH within the wider context of sustainability measurement;<br>• display a basic understanding of CSH measurement criteria;<br>• use basic written communication and specialist vocabulary that is basic; and<br>• identify reference material with basic vocabulary and accuracy. | [1–3] | Candidates may require some guidance to:<br>• produce a technical report that demonstrates an adequate understanding of CSH within the wider context of sustainability measurement;<br>• display a satisfactory understanding of CSH measurement criteria;<br>• use satisfactory written communication and specialist vocabulary that is adequate; and<br>• identify some reference material accurately and appropriately. | [4–6] | Candidates may require little guidance to:<br>• produce a technical report that provides a good overview of CSH within the wider context of sustainability measurement;<br>• display a clear understanding of CSH measurement criteria;<br>• use good written communication and specialist vocabulary that is competent; and<br>• identify most reference material accurately and appropriately. | [7–9] | Candidates work independently to:<br>• produce a technical report that provides a comprehensive and thorough overview of CSH within the wider context of sustainability measurement;<br>• display a clear and thorough understanding of CSH measurement criteria;<br>• use excellent written communication and specialist vocabulary that is highly competent; and<br>• identify all reference material accurately and appropriately. | [10–12] |
| **Award zero for work not worthy of credit.** | | | | | | | | |

## Assessment Criteria and Mark Bands for Unit A2 2: Environmental Building Performance and Measurement

| Assessment Objectives | Mark Band 1: Basic | Mark Range | Mark Band 2: Satisfactory | Mark Range | Mark Band 3: Good | Mark Range | Mark Band 4: Excellent | Mark Range |
|---|---|---|---|---|---|---|---|---|
| | Relevant material is poorly organised and presented with a lack of clarity and coherence. | | Relevant material is sufficiently organised and presented with some clarity and coherence. | | Relevant material is well organised and presented with a good degree of clarity and coherence. | | Relevant material is succinct, well organised and presented with a high degree of clarity and coherence. | |
| **AO2**<br><br>**Total: [20]** | Candidates may require considerable guidance and support to:<br>• identify a limited number of simple physical measurements required for the specified categories within the assessment task;<br>• make minimal or no reference to health and safety considerations;<br>• identify and source limited building data from a published source;<br>• produce simple calculations, which provide some basis for accumulation of CSH credits; and<br>• produce an overall CSH rating that is not related to the evidence provided. | [1–5] | Candidates may require some guidance to:<br>• identify a satisfactory number of physical measurements required for the specified categories within the assessment task;<br>• make satisfactory reference to health and safety considerations;<br>• identify and source satisfactory building data from more than one published source, not necessarily addressing all seven categories;<br>• produce appropriate calculations to adequately demonstrate the accumulation of CSH credits; and<br>• produce an overall CSH rating that bears some resemblance to the evidence provided. | [6–10] | Candidates may require little guidance to:<br>• identify a broad range of physical measurements (increasing in complexity) required for the specified categories within the assessment task;<br>• make clear reference to health and safety considerations;<br>• identify and source a good range of building data from a variety of published sources, addressing all seven categories;<br>• produce clear and accurate calculations to demonstrate the accumulation of CSH credits; and<br>• produce an overall CSH rating that is clearly related to the evidence provided. | [11–15] | Candidates work independently to:<br>• identify a comprehensive range of physical measurements (increasing in complexity) required for the specified categories within the assessment task;<br>• make detailed reference to health and safety considerations;<br>• identify and source a comprehensive range of building data from a variety of published sources, addressing all seven categories;<br>• produce comprehensive and accurate calculations to demonstrate the accumulation of CSH credits; and<br>• produce an overall CSH rating that is strongly related to the evidence provided. | [16–20] |
| **Award zero for work not worthy of credit.** | | | | | | | | |

## Assessment Criteria and Mark Bands for Unit A2 2: Environmental Building Performance and Measurement

| Assessment Objectives | **Mark Band 1: Basic** | **Mark Range** | **Mark Band 2: Satisfactory** | **Mark Range** | **Mark Band 3: Good** | **Mark Range** | **Mark Band 4: Excellent** | **Mark Range** |
|---|---|---|---|---|---|---|---|---|
| | Relevant material is poorly organised and presented with a lack of clarity and coherence. | | Relevant material is sufficiently organised and presented with some clarity and coherence. | | Relevant material is well organised and presented with a good degree of clarity and coherence. | | Relevant material is succinct, well organised and presented with a high degree of clarity and coherence. | |
| **AO3**<br><br>**Total: [18]** | Candidates may require considerable guidance and support to:<br>• make and record a limited number of physical measurements that may contain errors;<br>• record data in a given table with basic or no use of any other format to display data;<br>• make minimal or no reference to health and safety considerations; and<br>• produce a simple commentary with basic analysis that makes minimal links between the CSH rating and the building's performance. | [1–4] | Candidates may require some guidance to:<br>• make and record a satisfactory number of physical measurements that may contain minor errors;<br>• record data in a table/graph they devised, using at least one other format to display data;<br>• make satisfactory reference to health and safety considerations; and<br>• produce a satisfactory commentary with adequate links between the CSH rating and the building's performance. | [5–8] | Candidates may require little guidance to:<br>• make and record a good number of accurate physical measurements without errors;<br>• record data in a range of formats they devised that enhance the technical report;<br>• make clear reference to health and safety considerations; and<br>• produce a good commentary with clear links between the CSH rating and the building's performance. | [9–13] | Candidates work independently to:<br>• make and record a complete set of accurate physical measurements without errors and using high level technical skills;<br>• record data in a range of formats they devised that fully illustrate and enhance the technical report;<br>• make detailed reference to health and safety considerations; and<br>• produce an excellent commentary that makes extensive links between the CSH rating and the building's performance. | [14–18] |
| **Award zero for work not worthy of credit.** | | | | | | | | |

## Assessment Criteria and Mark Bands for Unit A2 2: Environmental Building Performance and Measurement (cont.)

| Assessment Objectives | Mark Band 1: Basic | Mark Range | Mark Band 2: Satisfactory | Mark Range | Mark Band 3: Good | Mark Range | Mark Band 4: Excellent | Mark Range |
|---|---|---|---|---|---|---|---|---|
| | Relevant material is poorly organised and presented with a lack of clarity and coherence. | | Relevant material is sufficiently organised and presented with some clarity and coherence. | | Relevant material is well organised and presented with a good degree of clarity and coherence. | | Relevant material is succinct, well organised and presented with a high degree of clarity and coherence. | |
| | Candidates may require considerable guidance and support to:<br>• produce a basic list of recommendations with limited or no rationale for each;<br>• provide a basic evaluation of the sustainability measurement processes used throughout the task; and<br>• use basic written communication and specialist vocabulary. | [1–4] | Candidates may require some guidance to:<br>• produce a satisfactory list of recommendations with an adequate rationale for each;<br>• provide a satisfactory evaluation of the sustainability measurement processes used throughout the task; and<br>• use satisfactory written communication and specialist vocabulary. | [5–8] | Candidates may require little guidance to:<br>• produce a good list of recommendations with a relevant rationale for each;<br>• provide a good evaluation of the sustainability measurement processes used throughout the task; and<br>• use good written communication and specialist vocabulary that is competent. | [9–13] | Candidates work independently to:<br>• produce a comprehensive list of recommendations with a strong and relevant rationale for each;<br>• provide a detailed and thorough evaluation of the sustainability measurement processes used throughout the task; and<br>• use excellent written communication and specialist vocabulary that is highly competent. | [14–18] |
| **Award zero for work not worthy of credit.** | | | | | | | | |

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