



ASSESSMENT and
QUALIFICATIONS
ALLIANCE

General Certificate of Secondary Education

Environmental Science 3441 2008

Material accompanying this Specification

- Specimen and Past Papers and Mark Schemes
- Reports on the Examination
- A Teacher's Guide

SPECIFICATION

This specification will be published annually on the AQA Website (www.aqa.org.uk). If there are any changes to the specification centres will be notified in print as well as on the Website. The version on the Website is the definitive version of the specification.

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Background Information

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The Revised General Certificate of Secondary Education

Following a review of the National Curriculum requirements, and the establishment of the National Qualifications Framework, all the unitary awarding bodies have revised their GCSE syllabuses for examination in 2003.

1.1 Changes at GCSE

Key Skills

All GCSE specifications must identify, as appropriate, opportunities for generating evidence on which candidates may be assessed in the “main” Key Skills of communication, application of number and information technology at the appropriate level(s). Also, where appropriate, they must identify opportunities for developing and generating evidence for addressing the “wider” Key Skills of working with others, improving own learning and performance and problem solving.

Spiritual, moral, ethical, social, cultural, environmental, health and safety and European Issues

All specifications must identify ways in which the study of the subject can contribute to an awareness and understanding of these issues.

ICT

The national curriculum requires that students should be given opportunities to apply and develop their ICT capacity through the use of ICT tools to support their learning. In each specification candidates will be required to make effective use of ICT in ways appropriate to the needs of the subject.

Tiering

In most subjects the scheme of assessment must include question papers, targeted at two tiers of grades, ie A* - D and C - G.

A safety net of an allowed Grade E will be provided for candidates entered for the higher tier who just fail to achieve Grade D. The questions will still be targeted at A* - D.

Citizenship

From 2002, students in England will be required to study Citizenship as a national curriculum subject. Each GCSE specification must signpost, where appropriate, opportunities for developing citizenship knowledge, skills and understanding.

1.2 Changes to the Science Criteria

This specification has been designed to meet the changes made to the GCSE Criteria for Science.

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Specification at a Glance

Environmental Science

This is the only specification in this subject offered by AQA.

There are two tiers of Assessment: Foundation (G-C) and Higher (D-A*).

A candidate can enter for one tier only.

GCSE Environmental Science (3441)	
Written Paper	
Foundation Tier (3441/F) 2 hours	80% of total marks 120 marks
Compulsory structured questions including extended writing	
OR	
Higher Tier (3441/H) 2 hours	80% of total marks 120 marks
Compulsory structured questions including extended writing	
There is common subject content for both tiers.	
Coursework	
	20% of total marks 60 marks
Centre-assessed report on a Practical Investigation of approximately 2000 words in length. Common scheme for both tiers.	
The skills assessed are:	
<ul style="list-style-type: none"> Planning Implementation Recording and data handling Interpretation Evaluation Communication 	

Foundation Tier
3441F
Higher Tier
3441H

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Availability of Assessment Units and Entry Details

- 3.1 Availability of Assessment Units** Examinations based on this Specification are available in the June examination series only.
-
- 3.2 Entry Codes** Normal entry requirements apply, but the following information should be noted.
- The **Subject Code** for entry to the GCSE award is 3441F for Foundation Tier and 3441H for Higher Tier.
-
- 3.3 Classification Codes** Each specification is assigned to a national classification code, indicating the subject area to which it belongs.
- Centres should be aware that candidates who enter for more than one GCSE qualification with the same classification code, will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.
- The classification code for this specification is 1750.
-
- 3.4 Private Candidates** This specification is available for private candidates. Private candidates should write to AQA for a copy of *'Supplementary Guidance for Private Candidates'*.
-
- 3.5 Access Arrangements and Special Consideration** AQA pays due regard to the provisions of the Disability Discrimination Act 1995 in its administration of this specification.
- Arrangements may be made to enable candidates with disabilities or other difficulties to access the assessment. An example of an access arrangement is the production of a Braille paper for a candidate with a visual impairment. Special consideration may be requested for candidates whose work has been affected by illness or other exceptional circumstances.
- Further details can be found in the Joint Council for Qualifications (JCQ) document:
Access Arrangements and Special Consideration Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examination
GCE, AEA, VCE, GCSE, GNVQ, Entry Level and Key Skills
 This document can be viewed via the AQA Website (www.aqa.org.uk)
- Applications for access arrangements and special consideration should be submitted to AQA by the Examinations Officer at the centre.

3.6 Language of Examinations

All assessment will be through the medium of English. Assessment materials will not be provided in Welsh or Gaelge.

Scheme of Assessment

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Introduction

4.1 National Criteria

This AQA GCSE in Environmental Science specification complies with the following:

- The GCSE Subject Criteria for Science;
- The GCSE, GCSE in vocational subjects, GCE, VCE, GNVQ and AEA Code of Practice 2006/7;
- The GCSE Qualification Specific Criteria;
- The Arrangements for the Statutory Regulation of External Qualifications in England, Wales and Northern Ireland: Common Criteria.

4.2 Rationale

Environmental Science is a relevant, integrative, practically based science combining studies of the physical and biological aspect of the environment with a consideration of their technological applications and economic and social interactions.

This specification provides an opportunity to study a range of issues of environmental importance and the scientific principles and concept which underpin them. The emphasis of the specification is on a scientific approach to the study of the environment, to provide the knowledge and understanding to enable an informed judgement to be made on matters of actual or potential environmental conflict.

4.3 Prior level of attainment and recommended prior learning

There is no specific prior level of attainment required for candidates to undertake a course of study based on this specification. However a level of scientific, literacy and numeracy skills commensurate with having followed a programme of study at Key Stage 3 is expected.

4.4 Progression

This qualification is a recognised part of the National Qualifications Framework. As such, GCSE provides progression from Key Stage 3 to further studies.

It lays an appropriate foundation for further study of environmental science or related subjects at AS/A level and GNVQ.

In addition it provides a worthwhile course for candidates of various ages and from diverse backgrounds in terms of general education and life-long learning.

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Aims

A course based on this specification should encourage candidates to:

- a. acquire a systematic body of scientific knowledge, and the skills needed to apply this in new and changing situations in a range of domestic, industrial and environmental contexts;
- b. acquire an understanding of scientific ideas, how they develop, the factors which may affect their development and their power and limitations;
- c. plan and carry out a range of investigations, considering and evaluating critically their own data and that obtained from other sources, and using ICT where appropriate;
- d. evaluate in terms of their scientific knowledge and understanding, the benefits and drawbacks of scientific and technological developments, including those related to the environment, personal health and quality of life, and considering ethical issues;
- e. select, organise and present information clearly and logically, using appropriate scientific terms and conventions, and using ICT where appropriate.

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Assessment Objectives

This specification requires that all candidates demonstrate the following assessment objectives in the context of the content and skills prescribed. Within each of the assessment objectives the assessment must take account of candidates' ability to communicate clearly and logically, using specialist vocabulary and conventions where appropriate.

6.1 Knowledge and Understanding (A01)

Candidates must be able to:

- a. recognise, recall and show understanding of specific scientific facts, terminology, principles, concepts and practical techniques;
- b. demonstrate understanding of the power and limitations of scientific ideas related to the environment, and factors affecting how these ideas develop;
- c. draw on existing knowledge to show understanding of the benefits and drawbacks of applications of environmental science;
- d. select, organise and present relevant information.

- 6.2 Application of knowledge and understanding, analysis and evaluation (A02)** Candidates must be able to:
- a. describe, explain and interpret phenomena, effects and ideas in the environment in terms of scientific principles and concepts, presenting arguments and ideas clearly and logically;
 - b. interpret and translate, from one form into another, data presented as continuous prose or in tables, diagrams and graphs;
 - c. carry out relevant calculations;
 - d. apply principles and concepts to unfamiliar situations, including those related to applications of environmental science in a range of domestic, industrial and environmental contexts;
 - e. evaluate scientific information related to the environment, and make informed judgements from it;
 - f. evaluate actions to prevent or mitigate environmental damage.
-

- 6.3 Investigative skills (A03)** Candidates must be able to:
- a. devise and plan investigations, drawing on scientific knowledge and understanding in selecting appropriate strategies;
 - b. demonstrate appropriate investigative methods, including safe and skilful practical techniques, obtaining data which are sufficient and of appropriate precision, recording these methodically;
 - c. interpret data to draw conclusions which are consistent with the evidence, using scientific knowledge and understanding, whenever possible, in explaining their findings;
 - d. evaluate data and methods.
-

- 6.4 Quality of Written Communication** Where candidates are required to produce extended written material in English, they will be assessed on the quality of written communication. Candidates will be required to:
- a. present relevant information in a form that suits its purposes;
 - b. ensure that text is legible and that spelling, punctuation and grammar are accurate, so that meaning is clear.

Quality of written communication will be assessed in the written papers and coursework. This assessment is, therefore, included in all three assessment objectives.

Scheme of Assessment

7.1 Assessment Units

The Scheme of Assessment comprises two components.

Written Paper	2 hours
80 % of the marks	120 marks

There are separate papers for Foundation (3441/1F) and Higher (3441/1H) Tiers. Common questions, at the C/D standard, will be used across the two tiers of papers.

The subject content is common to both tiers.

All questions will be compulsory, short answer and structured questions.

There will be opportunities for answers to be written in continuous prose. The marking of candidate's continuous prose will take into account the quality of written communication.

Coursework	
20 % of the marks	60 marks

The report on the Practical Investigation is marked by the teacher in the centre and moderated by AQA. The scheme is common to both tiers.

The following six areas will be assessed:

- Planning
- Implementation
- Recording and Data Handling
- Interpretation
- Evaluation
- Communication

Detailed instructions are provided later in this specification.

7.2 Weighting of Assessment Objectives

The approximate relationship between the relative percentage weighting of the Assessment Objectives (AOs) and the overall Scheme of Assessment is shown in the following table:

Assessment Objectives	Component Weightings (%)		Overall Weighting of AOs (%)
	1	2 (Centre-assessed coursework)	
1. Knowledge and understanding	45	-	45
2. Application, analysis and evaluation	30	-	30
3. Investigative skills	5	20	25
Overall Weighting of Units (%)	80	20	100

Candidates' marks for each assessment unit are scaled to achieve the correct weightings.

7.3 Terminal Examination Requirements

The requirements of the ideas and evidence section of Environmental Science need to be met through the teaching of the subject content in this specification. Due to the very nature of Environmental Science, the subject content abounds with examples of topics which encompass social, moral, religious and economic views of how controversial scientific and technological issues affect the environment. Such examples include:

- Theme 1; the Greenhouse Effect, sustainable development, extraction and transport of fossil fuels, nuclear power and renewable resources.
- Theme 2; mineral extraction.
- Theme 3; conservation of wildlife and landscape.
- Theme 4; World population and food supplies, selective breeding, Genetically Modified Organisms, animal welfare and organic farming.
- Theme 5; waste disposal and recycling, pollution including that of water, air and by oil and heat.

However, this is not an exhaustive list and other topics may be used to ensure that the requirement for the assessment of 'Ideas and evidence in Science' is met. As such topics pervade the essence of Environmental Science it is not appropriate to identify particular topics for assessment.

Ideas and evidence

The subject content includes classic historical and contemporary contexts selected as being appropriate for the teaching/learning and assessment of ideas and evidence in science. These contexts may also be used to assess knowledge and understanding of relevant scientific ideas from the subject content.

Through these contexts, candidates should be able to apply the following ideas appropriately to information they are given about historically important scientific discoveries and to currently controversial scientific and technological issues:

- a. that scientists report their findings to other scientists in special journals. The reports are not published unless the scientific research is of good quality and the findings are not usually accepted unless they can be repeated by other scientists.
- b. that members of the public depend on the mass media (TV, newspapers, radio etc.) to keep them informed about issues involving science and technology. These may be biased but have a big influence on:
 - the issues that are discussed;
 - the points of view people take on these issues;
 - decisions about what research should be funded;
- c. that to explain their findings, scientists need to use their imaginations so that there can be more than one explanation of the same findings;
- d. that scientists, like other people:
 - are reluctant to give up explanations that have served them well in the past;
 - have scientific, moral, religious and social views that are influenced by the views of the society in which they live;
- e. that a new explanation is more likely to be accepted if it can be used to make predictions which are then observed to be correct;
- f. that scientists may be uncertain about whether or not a factor increases the chance of a particular outcome. This is especially likely:
 - in complex situation;
 - when the evidence is based on a small number of cases;
 - if it is difficult to explain how the factor could cause the outcome;
- g. that science-based technology provides people with many of the things they most value in life but can also, usually unintentionally, harm people and the environment so that benefits always need to be weighed against costs (economic, environmental and social);
- h. that even when there is full scientific agreement about the likely effects of some technological process, there is always a further (moral) question about whether, on balance, it should be allowed.

Assessment

Questions designed to assess ideas and evidence through the contexts in the subject content will be included in the terminal examination papers and will contribute at least 5% to the overall award. Any information needed by candidates to answer these questions, in addition to that which is included in the subject content, will be provided in the questions themselves.

Subject Content

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Summary of Subject Content

Theme 1: Air, Water and Energy

- 9.1 Air: the atmosphere.
- 9.2 Water: the water cycle, uses of water, water supply, treatment and conservation.
- 9.3 Energy: renewable and non-renewable energy sources, fossil fuels, nuclear, energy conservation.

Theme 2: Rocks and Soils

- 9.4 Rocks: uses, mineral extraction.
- 9.5 Soils: formation, properties, erosion, conservation.

Theme 3: Organisms and the Environment

- 9.6 Life Processes: photosynthesis, respiration.
- 9.7 Ecosystem Processes: energy flow, circulation of materials.
- 9.8 Wildlife and Landscape Conservation: reasons, methods.

Theme 4: Farming, Fisheries and Forestry

- 9.9 Population: Population and food supply.
- 9.10 Intensification of Farming: mechanisation, fertilisers and pesticides, selective breeding, genetically modified organisms, controlled environments, Government policy, organic farming.
- 9.11 Fisheries: fish farming, sea fisheries.
- 9.12 Forestry: cultivation, uses, commercialism.

Theme 5: Waste and Pollution

- 9.13 Waste and Recycling: disposal, re-use, recycling.
- 9.14 Water Pollution: nutrients, organic matter, thermal, oil, monitoring and controlling.
- 9.15 Air Pollution: The Greenhouse Effect, Global Climatic Change, acid deposition, ozone depletion.

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Theme 1: Air, Water and Energy

9.1 Air

The composition of the atmosphere

- The relative proportions of nitrogen, oxygen and carbon dioxide in the atmosphere.

The importance of the atmosphere

The significance of atmospheric gases in the following contexts:

- as a source of oxygen, carbon dioxide and nitrogen for living organisms;
- protection from ultra violet radiation provided by the ozone layer;
- importance of carbon dioxide and other gases in controlling the Earth's temperature through the Greenhouse Effect;
- water vapour as an important part of the water cycle.

9.2 Water

The water cycle

- The main stages and processes involved in the water cycle, to include evaporation, condensation, precipitation, interception, infiltration, transpiration, ground water, the water table and run-off.

Uses of water

- The various, sometimes competing, uses of water, including industry, agriculture, domestic supply, recreation, transport, energy generation and nature conservation.
- Candidates should study an example of a multiple use water management scheme.

Variations in water availability

- Some areas have water shortages while other areas have surpluses.
- Water availability may fluctuate seasonally.

Water supply

Provision of water supplies of varying quality from:

- rivers;
- surface storage reservoirs (including factors affecting siting and effects on the natural environment and local communities);
- aquifers.

Water treatment

- Filtration, sedimentation and chlorination as stages in the process of drinking water treatment.

Water conservation

Conservation measures include:

- prevention of leaks;
- water meters;
- re-use of waste water for low quality uses (grey water recycling);
- domestic economy measures, including dual flush toilets;
- hosepipe bans and other restrictions.

9.3 Energy

Renewable and non-renewable resources

The concept of renewable and non-renewable resources:

- renewable resources are not depleted by use and/or are capable of rapid regeneration;
- non-renewable resources may be regenerated only over exceedingly long time scales so that they become depleted as they are used;
- estimated lifetimes of non-renewable energy resources.

Sustainable development

- Definition

Sustainable development was defined by the Brundtland Commission in 1987 as “development which meets present needs without compromising the ability of future generations to achieve their needs and aspirations”.

Candidates will **not** be expected to state the definition in these terms but should be able to provide an appropriate paraphrase and to demonstrate understanding of the concept of sustainability. They should also be aware that there is continuing debate as to the levels of resource use which may be considered sustainable.

- Agenda 21

Candidates should be aware of the development of Local Agenda 21 policies concerning waste minimisation, pollution control and transport policies following the UNCED “Earth Summit” in Rio de Janeiro (1992).

The fossil fuels

- The main fossil fuels are coal, crude oil (petroleum) and natural gas.
- Processes involved in the formation of fossil fuels - burial of organic matter under anaerobic conditions with heat and pressure causing chemical changes over long periods of time.

Uses of fossil fuels

- Combustion for heating, electricity generation and transport.
- Manufacture of lubricants, petrochemicals and plastics.

Extraction and transport of fossil fuels

The main methods used to extract and transport fossil fuels and the environmental impacts associated with these:

- the impacts of open cast and deep mining of coal including noise, dust, subsidence, transport impacts, eyesore, habitat loss and spoil tipping;
- onshore and offshore wells for oil and natural gas;
- impacts of pipeline construction and operation;
- ocean tanker transport of oil.

Electricity generation using fossil fuels	<ul style="list-style-type: none">• Major components of coal fired power stations, including boiler, turbine, generator and cooling towers.• Energy transfers and transformations involved in electricity generation in a coal fired power station.• Environmental impacts of such power stations, including visual impact, traffic, noise and emissions to air and water.
Nuclear power	<ul style="list-style-type: none">• Energy is released when small amounts of matter in the nuclei of atoms are destroyed.
Nuclear fusion	<ul style="list-style-type: none">• Nuclear fusion involves the joining together of the nuclei of small atoms such as hydrogen at very high temperatures.• Fusion is the source of energy in the sun but on Earth is still being developed as a practicable energy source.
Nuclear fission	<ul style="list-style-type: none">• Nuclear fission involves the splitting of the nuclei of large atoms such as Uranium 235.• The main features and processes of a nuclear power station including reactor core, fuel rods, control rods, coolant, containment and chain reaction.• Factors involved in the location of nuclear power stations.• Advantages of nuclear fission for electricity generation including use of small amounts of an abundant fuel and production of relatively small amounts of pollution.• Disadvantages including production of radioactive waste, environmental contamination caused by reactor accidents and opposition from pressure groups such as Greenpeace and Friends of the Earth.
Renewable energy resources	<ul style="list-style-type: none">• The main renewable energy resources are solar (photovoltaic and solar heating), hydro-electric power (HEP), wind power, wave power, biofuels (wood, crop wastes, sugar/alcohol, methane from waste, dung), geothermal power, tidal power.• The means by which energy is harnessed from wind and tidal sources, the energy transformations involved and the location factors relevant to these technologies.• Advantages and disadvantages of renewable energy sources, including conservation of non-renewable resources, reduced pollution emissions, visual/aesthetic impact, ecological effects and variability/unreliability of resources.
Energy conservation	<p>Energy can be conserved by avoiding the unnecessary use of energy and by increasing the efficiency with which energy is used:</p> <ul style="list-style-type: none">• major ways in which energy can be conserved including building insulation, low-energy light-bulbs, better vehicle design, mass transport systems for goods and passengers, reduction in unnecessary packaging and recycling of materials.

Theme 2: Rocks and Soils

9.4 Rocks

Uses of rocks

- The uses of:
 - limestone/chalk for road stone, cement, agricultural lime;
 - sand and gravel for mortar, concrete, bulk fill.

Impacts of mineral extraction

- The negative impacts of mineral extraction including loss or damage to agricultural land and wildlife habits, visual impact, noise, dust and traffic impacts.
- The positive impacts of mineral extraction including the gaining of vital resources and stimulus to local economies and employment.
- The reclamation and after use of sites used for mineral extraction.

9.5 Soils

Formation of soil

- The main components of soil are organic and mineral matter, air, water and living organisms.
- The process of soil formation occurs over long periods of time so that soil may easily become a non-renewable resource.

Properties of soil

- Soil texture:
 - as a function of the varying proportion of sand, silt and clay;
 - characteristics of sand- and clay-dominated soils in terms of water-holding, drainage, nutrient status and ease of cultivation;
 - practical determination of soil texture by sieving or a hand texturing method.
- Soil pH:
 - the nature of the pH scale;
 - an appreciation that low pH (acidity) is associated with low soil fertility;
 - correction of soil pH using lime;
 - measurement of soil pH.
- Soil nutrients:
 - nitrogen, phosphorus and potassium as the three major plant nutrients;
 - use of fertilisers to enhance fertility.

Soil erosion

- Soil erosion:
 - by wind and water;
 - triggered by deforestation, hedgerow removal, overgrazing and overcropping;
 - as a component of desertification, along with changes in climate, vegetation and hydrology.

Soil conservation

- The impact of soil erosion can be reduced by techniques including hedging and shelter belts, contour ploughing, strip cultivation, terracing, crop rotation and reforestation.

Theme 3: Organisms and the Environment

9.6 Life Processes

Life Processes

- Photosynthesis:
 - simple summary equation for photosynthesis;
 - the importance of light energy and chlorophyll;
 - the factors affecting the rate of photosynthesis including carbon dioxide, water, light, suitable temperature and chlorophyll;
 - the importance of photosynthesis in modifying the environment by removing carbon dioxide from, and adding oxygen to, the atmosphere.
- Respiration:
 - simple summary equation for aerobic respiration;
 - an appreciation that respiration can also occur under anaerobic conditions, including fermentation producing methane.

9.7 Ecosystem Processes

Energy flow

Energy flows through ecosystems, arriving as 'high grade' light energy and ending up as low grade, dispersed heat energy.

- Food chains and food webs.
- Trophic levels and the principle of progressive energy loss along food chains.
- Pyramids of numbers, biomass and energy.

The circulation of materials

Materials circulate between the lithosphere (rocks and soil), the hydrosphere (water), the atmosphere and living organisms in nutrient (or biogeochemical) cycles.

- Carbon cycle - the main stages and processes in the carbon cycle, to include photosynthesis, respiration, decomposition of organic matter, fossil fuel formation, combustion, solution of carbon dioxide in water and limestone formation.
- Nitrogen cycle - the main stages and processes in the nitrogen cycle, to include fixation of atmospheric nitrogen by lightning, nitrogen-fixing bacteria and industrial nitrogen fixation, absorption by plants, nitrifying and denitrifying bacteria.

9.8 Wildlife and landscape conservation

Reasons for conservation	The aesthetic, ethical, educational, economic, ecological and recreational reasons for the conservation of individual species, habitats and overall biodiversity.
Conservation methods	Examples of the conservation of wildlife and habitats should be studied to illustrate: <ul style="list-style-type: none">• the need for conservation and the nature of threats to habitats and/or species;• active management of habitats;• captive breeding and reintroduction programmes;• legal protection for species and habitats, to include reference to the Convention of International Trade in Endangered Species (CITES) and UK Sites of Special Scientific Interest (SSSI);• involvement of organisations in conservation, to include the role of English Nature or equivalent bodies in the UK and of at least one voluntary sector organisation.
Landscape protection	Areas of attractive landscape may need protection and management to prevent inappropriate development and to accommodate increasing visitor numbers. <ul style="list-style-type: none">• UK National Parks<ul style="list-style-type: none">- distribution and reasons for designation (in general terms);- the fact that the majority of land in UK National Parks remains privately owned, with consequent conflicts of interest;- visitor pressure and management strategies;- candidates should study these concepts in the context of one National Park.

Theme 4: Farming, Fisheries and Forestry

9.9 Biotic resources and population

Population and food supply	<ul style="list-style-type: none">• Rapid growth of World Population especially in Less Economically Developed Countries (LEDCs).• The inequality of food supplies to include malnutrition and famine in LEDCs and expectations of year round availability in More Economically Developed Countries (MEDCs).
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9.10 The Intensification of Farming

Mechanisation	<ul style="list-style-type: none">• The effects to include landscape change, hedgerow destruction and soil compaction.
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Increased use of fertilisers and pesticides	<ul style="list-style-type: none">• Benefit of agrochemical use - increased yields.• Effects of pesticides.• Effects of increased fertiliser use to include eutrophication and contamination of drinking water.
Selective breeding and genetic modification of crops and livestock	<ul style="list-style-type: none">• Selective breeding:<ul style="list-style-type: none">- basic understanding of the principle of selective breeding;- benefits, including higher yields and improved disease resistance and climatic tolerance;- potential risks of large scale adoption of new varieties including vulnerability to pest attack and narrowing of gene pools.• Genetic modification:<ul style="list-style-type: none">- an appreciation that GM technology involves the transfer of genetic material between species (unlike selective breeding);- potential benefits including increased yields, improved disease and pest resistance and reduced use of agrochemicals;- objections to GM including moral, religious and ethical concerns, risks of transfer of genes to other organisms, e.g. by cross pollination, and fears of risks to human health.
Crop and livestock production in controlled environments	<ul style="list-style-type: none">• Increased productivity related to control of climate (including the use of glasshouses and animal housing), nutrition and restriction of movement.• Concerns, to include moral/ethical concerns relating to animal welfare and increased use of agrochemicals and veterinary medicines which may affect human health.
Government Policy	<ul style="list-style-type: none">• Support given to farmers under the EU Common Agricultural Policy.• Overproduction and 'food mountains'.• Measures to limit overproduction, including milk quotas and set-aside.
Organic farming	<ul style="list-style-type: none">• Environmental and health related concerns have led to growing interest in organic farming incorporating:<ul style="list-style-type: none">- use of organic fertilisers;- crop rotation;- biological control and other alternative methods of pest control;- animal welfare measures.

9.11 Fisheries

Fish farming	<ul style="list-style-type: none">• Advantages including local employment, often in remote rural areas, cheaper fish and reduced exploitation of wild stocks.• Disadvantages, including visual impact of fish farms, contamination of water bodies by faeces, wasted food and medications and the risks of disease spreading from farmed fish to wild stocks.
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Sea fisheries

- Overfishing and decline of fish stocks.
- Conservation measures to include quotas, mesh size regulations and the existence of the Common Fisheries Policy.

9.12 Forestry

Forestry

- Candidates should be aware that forestry refers to the cultivation of trees as a crop as opposed to the logging of natural forests.
- Uses of wood, including paper, furniture and buildings.
- Commercial forestry in the UK:
 - advantages of commercial forestry including reduced reliance on imports, reduced exploitation of natural forests, recreational value of forests and local employment;
 - criticisms of commercial forestry in the UK including landscape impact, loss of wildlife habitats to forestry and lesser conservation value of commercial plantations.

Theme 5: Waste and Pollution

9.13 Waste and Recycling

Waste disposal

The problems of domestic and commercial waste to include:

- cost of disposal;
- health hazards;
- the environmental impact of landfill and incineration.

Re-use and recycling

Waste reduction and resource saving by:

- re-use as exemplified by glass milk bottles, deposit paid containers and second-hand and charity shops;
- recycling of materials including glass, paper, plastics and metals.

9.14 Water Pollution

Nutrient enrichment

- Sources:
 - sewage effluent;
 - agricultural fertilisers.
- Effects:
 - risk to human health (nitrates and the blue baby syndrome);
 - ecological effects including algal blooms leading to increased decay and consequent deoxygenation of water bodies and effects on aquatic organisms.
- Remedies:
 - phosphate free detergents;
 - sewage treatment;
 - limits on agricultural use of fertilisers – Nitrate Sensitive Areas.

Organic Matter Pollution	<ul style="list-style-type: none">• Sources:<ul style="list-style-type: none">- sewage;- farm wastes.• Effects:<ul style="list-style-type: none">- deoxygenation due to decomposition.• Remedy:<ul style="list-style-type: none">- the principles of sewage treatment to include screening, maceration, sedimentation (settlement) and biological treatment.
Thermal Pollution	<ul style="list-style-type: none">• Source:<ul style="list-style-type: none">- discharged cooling water.• Effects:<ul style="list-style-type: none">- lowering of oxygen concentration of water and consequent effects on aquatic organisms.• Remedy:<ul style="list-style-type: none">- use of cooling towers to cool water before discharge.
Oil Pollution	<ul style="list-style-type: none">• Sources:<ul style="list-style-type: none">- pollution of the marine environment by oil as a result of oil rig, pipeline or shipping operations.• Effects:<ul style="list-style-type: none">- damage to marine organisms, external and by ingestion;- contamination of shorelines;- economic effects on tourism and fisheries.• Remedies:<ul style="list-style-type: none">- improved oil tanker construction;- containment, dispersal and clean-up techniques.
Monitoring and control of water pollution	<ul style="list-style-type: none">• The pollution control function of the Environment Agency.• The existence of discharge consents for sewage works, industrial and other premises.• Use of Indicator Species to monitor water quality.

9.15 Air pollution

The Greenhouse Effect and Global Climatic Change	<ul style="list-style-type: none">• The importance of the Greenhouse Effect as a natural phenomenon maintaining global temperatures at suitable levels for life.• The mechanism of the Greenhouse Effect (atmosphere largely transparent to incoming short wavelength radiation, heating of ground, re-radiation at longer wavelengths, absorption of long wavelength radiation by carbon dioxide, methane and other gases).
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- Possible effects of the enhanced Greenhouse Effect:
 - global climatic change including possible effects on temperature, precipitation and frequency and intensity of storms;
 - sea level rise;
 - possible redistribution of habitable/cultivable area;
 - ecological effects.
- Candidates should be aware of the scientific uncertainty concerning the degree to which Global Climatic Change may be already occurring and the nature and magnitude of possible consequences.
- The need to reduce emissions of Greenhouse Gases and the difficulty of achieving international agreement (Kyoto Convention).
- Possible remedies:
 - more efficient combustion technology;
 - development of more energy efficient transport;
 - personal lifestyle choices which may reduce fossil fuel use, such as using showers rather than baths or walking rather than using the car;
 - tree planting to absorb carbon dioxide in photosynthesis.

Acid deposition

- Combustion of fossil fuels as the main source of oxides of sulphur and nitrogen.
- The distinction between dry and wet deposition.
- The effects of acid deposition: corrosion of buildings, destruction of forests and loss of aquatic life.
- Acid deposition as a transboundary problem.
- Possible remedies:
 - the Clean Air Acts;
 - catalytic converters;
 - flue gas desulphurisation;
 - fuel substitution - low sulphur coal or coal to gas substitution.
- Recognition that, in the UK at least, emissions of sulphur dioxide have fallen significantly since the 1960's resulting, amongst other things, in significant recoveries in the distribution of lichens, which can be used as indicators of pollution by this gas.
- Pollutants released by motor vehicles may be of great significance, particularly in urban areas;
 - pollutants, including oxides of nitrogen, carbon monoxide and unburnt hydrocarbons;
 - production of photochemical smog and ground level ozone;
 - possible health effects;
 - possible remedies including traffic reduction and catalytic converters.

Ozone depletion

- The nature of ozone as a three-atom molecule of oxygen.
- The role of ozone in the upper atmosphere in screening the Earth from dangerous ultraviolet radiation.
- The role of CFC compounds in ozone depletion.
- Hazards associated with ozone depletion:
 - damage to plants, including crops;
 - increased risk of skin cancers and eye cataracts.
- The Montreal Protocol as an example of an international pollution control agreement.

Key Skills and Other Issues

10

Key Skills – Teaching, Developing and Providing Opportunities for Generating Evidence

10.1 Introduction

The Key Skills Qualification requires candidates to demonstrate levels of achievement in the Key Skills of *Communication*, *Application of Number* and *Information Technology*.

The units for the ‘wider’ Key Skills of *Improving own Learning and Performance*, *Working with Others* and *Problem-Solving* are also available. The acquisition and demonstration of ability in these ‘wider’ Key Skills is deemed highly desirable for all candidates, but they do not form part of the Key Skills Qualification.

Copies of the Key Skills Units may be down loaded from the QCA Website (www.qca.org.uk/keyskills).

The units for each Key Skill comprise three sections:

- A What you need to know.
- B What you must do.
- C Guidance.

Candidates following a course of study based on this Specification for Environmental Science can be offered opportunities to develop and generate evidence of attainment in aspects of the Key Skills of *Communication*, *Application of Number*, *Information Technology*, *Improving own Learning and Performance*, *Working with Others* and *Problem-Solving*. Areas of study and learning that can be used to encourage the acquisition and use of Key Skills, and to provide opportunities to generate evidence for Part B of the units, are signposted below.

10.2 Key Skills Opportunities in Environmental Science

Candidates following a course of study based on this specification for Environmental Science can be offered opportunities to develop and generate evidence of attainment in aspects of all of the Key Skills. The broad and multi-disciplinary nature of Environmental Science that calls upon candidates’ abilities to demonstrate the transferability of their knowledge, understanding and skills, make it an ideal vehicle for candidates to produce evidence for Key Skills.

Communication Level 1

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
C1.1 Take part in discussions	✓	✓	✓	✓	✓
C1.2 Read and obtain information	✓	✓	✓	✓	✓
C1.3 Write different types of documents	✓	✓	✓	✓	✓

Communication Level 2

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
C2.1a Contribute to discussions	✓	✓	✓	✓	✓
C2.1b Give a short talk	✓	✓	✓	✓	✓
C2.2 Read and summarise information	✓	✓	✓	✓	✓
C2.3 Write different types of documents	✓	✓	✓	✓	✓

Application of Number Level 1

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
N1.1 Interpret information from different sources	✓	✓	✓	✓	✓
N1.2 Carry out calculations	✓	✓	✓	✓	✓
N1.3 Interpret results and present findings	✓	✓	✓	✓	✓

Application of Number Level 2

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
N2.1 Interpret information from different sources	✓	✓	✓	✓	✓
N2.2 Carry out calculations	✓	✓	✓	✓	✓
N2.3 Interpret results and present findings	✓	✓	✓	✓	✓

Information Technology Level 1

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
IT1.1 Find, explore and develop information	✓	✓	✓	✓	✓
IT1.2 Present information, including text, numbers and images	✓	✓	✓	✓	✓

Information Technology Level 2

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
IT2.1 Search for and select information	✓	✓	✓	✓	✓
IT2.2 Explore and develop information and derive new information	✓	✓	✓	✓	✓
IT2.3 Present combined information, including text, numbers and images	✓	✓	✓	✓	✓

Working with Others Level 1

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
WO1.1 Confirm what needs to be done and who is to do it	✓	✓	✓	✓	✓
WO1.2 Work towards agreed objectives	✓	✓	✓	✓	✓
WO1.3 Identify progress and suggest improvements	✓	✓	✓	✓	✓

Working with Others Level 2

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
WO2.1 Plan work and confirm working arrangements	✓	✓	✓	✓	✓
WO2.2 Work cooperatively towards achieving identified objectives	✓	✓	✓	✓	✓
WO2.3 Exchange information on progress and agree ways of improving work with others	✓	✓	✓	✓	✓

Improving own Learning and Performance Level 1

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
LP1.1 Confirm short-term targets and plan how these will be met	✓	✓	✓	✓	✓
LP1.2 Follow plan to meet targets and improve performance	✓	✓	✓	✓	✓
LP1.3 Review progress and achievements	✓	✓	✓	✓	✓

Improving Own Learning and Performance Level 2

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
LP2.1 Help set short-term targets and plan how these will be met	✓	✓	✓	✓	✓
LP2.2 Use plan and support from others, to meet targets	✓	✓	✓	✓	✓
LP2.3 Review progress and identify evidence of achievements	✓	✓	✓	✓	✓

Problem Solving Level 1

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
PS1.1 Confirm understanding of given problems	✓	✓	✓	✓	✓
PS1.2 Plan and try out ways of solving problems	✓	✓	✓	✓	✓
PS1.3 Check if problems have been solved and describe the results	✓	✓	✓	✓	✓

Problem Solving Level 2

What you must do ...	Signposting of Opportunities for Generating Evidence in Subject Content				
	Theme 1	Theme 2	Theme 3	Theme 4	Theme 5
PS2.1 Identify problems and come up with ways of solving them	✓	✓	✓	✓	✓
PS2.2 Plan and try out options	✓	✓	✓	✓	✓
PS2.3 Apply given methods to check if problems have been solved and describe the results	✓	✓	✓	✓	✓

10.3 Further Guidance

More specific guidance and examples of tasks that can provide evidence of single Key Skills, or composite tasks that can provide evidence of more than one Key Skill are given in the AQA specification support material, particularly the Teachers' Guide.

11

Spiritual, Moral, Ethical, Social, Cultural and Other Issues

11.1 Spiritual, Moral, Ethical, Social, Cultural and Other Issues

The study of Environmental Science lends itself to consideration of many spiritual, moral, ethical, social and cultural issues. Candidates are encouraged to understand and discuss the implications of decisions that may influence many communities, populations and individuals. The importance of all aspects of the global environment and the necessity to achieve sustainability to ensure the continuation of the human race is stressed.

The following sections of the subject content may be particularly apposite for analysis and discussion of these issues:

- the Greenhouse Effect and Global Climatic Change
- factors affecting the atmosphere
- the use of and the demand for water
- energy resources
- the impacts of mineral extraction
- wildlife and landscape conservation
- sustainability in the context of resource use and waste management.

11.2 European Dimension

AQA has taken account of the 1988 Resolution of the Council of the European Community in preparing this specification and associated specimen papers.

European examples should be used where appropriate in the delivery of the subject content.

11.3 Environmental Issues

AQA has taken account of the 1988 Resolution of the Council of the European Community and the Report *“Environmental Responsibility: An Agenda for Further and Higher Education”* 1993 in preparing this specification and associated specimen papers.

The nature of this specification makes it ideally suited to develop in candidates an understanding of their responsibility to the environment. It enables candidates to explore international debates surrounding environmental issues and to evaluate the arguments.

11.4 Citizenship

This specification allows treatment of aspects of citizenship through the contribution made to candidates' moral, social and cultural development and through the opportunities to promote an understanding of, and responsible attitudes towards, environmental issues. In this way, the subject contributes to the development of candidates' social and moral responsibility.

11.5 Avoidance of Bias

AQA has taken great care in the preparation of this specification and associated papers to avoid bias of any kind.

11.6 Health and Safety

When working with equipment and materials, in practical activities and in different environments, including those that are unfamiliar, candidates should be taught:

- about hazards, risks and risk control;
- to recognise hazards, assess consequent risks and take steps to control the risks to themselves and others;
- to use information to assess the immediate and cumulative risks;
- to manage their environment to ensure the health and safety of themselves and others;
- to explain the steps they take to control risks.

An assessment of risks involved in all practical procedures must be made before work commences under the COSHH regulations. Attention is drawn to the hazards associated with many materials and processes associated with the specification. Detailed information may be found in pamphlets on safety issued by the Department for Education and Employment. In addition, all work involving live organisms must be legal and humane. It is expected that all candidates will be familiar with appropriate standards of safety in all aspects of practical work.

11.7 Use of Organisms

Nothing in this specification requires candidates, teachers or lecturers to kill animals. Live animals brought into the laboratory for study should be kept unstressed in suitable conditions and should, wherever possible, be returned unharmed to their habitats. Studies of animals and plants in their habitats should aim at minimal disturbance.

11.8 Mathematical requirements

Candidates are expected to be familiar with the following mathematical skills in each tier:

Number:

- the four operations, applied to whole numbers and decimals;
 - efficient use of a calculator;
 - use of squares and square roots;
-

- use of decimals, ratios, fractions and percentages;
- estimation and approximation of solutions to numerical problems;
- understand and use direct and inverse proportion.

Algebra:

- substitution of numbers into simple formulae and equations expressed in words and symbols;
- transformation of simple equations.

Shape, Space and Measures:

- use of appropriate measures of length, mass, time;
- use of area and volume.

Handling Data:

- construction of tables of data;
- select appropriate axes and scales for graph plotting;
- construction of diagrams and graphs, including bar charts and pie charts and use of lines of best fit where appropriate;
- interpretation of tables, diagrams and graphs, and from them draw simple inferences;
- calculation of arithmetic mean;
- use sampling methods, considering their reliability.

Drawing Graphs

Additional guidance relating to drawing graphs is given below.

- Candidates will be told what type of graph to draw, i.e. bar or line.
- Where continuous information is represented and interpolation is theoretically possible, a 'best fit' smooth curve or line graph will be appropriate.
- Where interpolation is inappropriate then joining of points is acceptable.
- Where there is no indication of the nature of the line required, then candidates can adopt either method.

11.9 Information and Communication Technology

Through the teaching of this specification candidates should be given opportunities to apply and develop their ICT capability. Although the scheme of assessment in this specification does not assess directly candidates' effective use of ICT, teaching of the specification can encourage use of ICT. In addition, there are opportunities to generate evidence of attainment in the key skill of information technology.

Candidates should be given opportunities to support their work by being taught to:

- a. find things out from a variety of sources, selecting and synthesising the information to meet their needs and developing an ability to question its accuracy, bias and plausibility;
- b. develop their ideas using ICT tools to amend and refine their work and enhance its quality and accuracy;
- c. exchange and share information, both directly and through electronic media;

Examples of opportunities in the subject content for the use of ICT are as follows.

Candidates could:

- use multimedia sources to see things that cannot readily be observed at first hand (see 9.3, 9.5)
- use the internet to find information about commercial applications and current developments (see 9.2, 9.3, 9.4, 9.8, 9.9, 9.10, 9.11, 9.12, 9.13, 9.14, 9.15)
- use spreadsheets for modelling or data analysis (see 9.3, 9.5, 9.8)
- use software simulations (see 9.1, 9.2, 9.7, 9.10)
- use databases to explore patterns (see 9.2, 9.5, 9.8).

ICT is a useful tool in relation to coursework (see Section 15.5). This could involve data logging, spread sheets and the use of word processors to write up investigations. Spelling and grammar checks in this latter activity will also help to develop writing skills.

ICT can also help the teaching of topics that are difficult to teach interestingly in other ways.

Centre-Assessed Component

12

Nature of the Centre-Assessed Component

Teachers are required to make internal assessments of the candidates' coursework. The coursework comprises **one** report on a Practical Investigation in the order of approximately 2000 words in length.

The internal assessment of coursework is designed to test investigative skills. The candidates should demonstrate the ability to:

- devise and plan an investigation, drawing on scientific knowledge and understanding in selecting appropriate strategies;
- demonstrate appropriate investigative methods, including safe and skilful practical techniques, obtaining data which are sufficient and of appropriate precision, recording these methodically;
- interpret data to draw conclusions which are consistent with the evidence, using scientific knowledge and understanding, whenever possible, in explaining their findings;
- evaluate data and methods.

The investigation will assess the candidate's attainment out of 60 marks. This will be weighted as 20% of the examination.

Guidance on Setting the Centre-Assessed Component

13.1 Nature of Coursework

It is envisaged that coursework will arise from a variety of contexts as part of the candidate's normal work during the course e.g. classroom activities, fieldwork or laboratory investigations. The investigation **must** contain an element of original data collected by the candidate (primary data) although this can be supported by secondary data obtained from other sources. Group work is permissible, but the individual candidate's role must be clearly identified.

Teachers must ensure that the investigation adequately covers the assessment criteria and that it is of an environmental nature demonstrating the integration of the physical, biotic and human environments.

The following examples are provided to indicate titles of environmental investigations which could be considered appropriate for some candidates. The list should not be taken as one from which a choice of titles should be made but is provided solely to give examples.

Examples:

- An investigation into the degree of pollution (e.g. in water) and its effect on the macro- and micro-environment.
- An investigation of the effect of mining or quarrying on the environment.
- The degree of acidification (i.e. acid rain) in the local area, with consideration of the possible sources and environmental effects.
- An assessment of the advantages and disadvantages of a new motorway or road-building scheme in the local area.
- The effects of a recent residential development on a rural area.
- A study of domestic water consumption, fuel use or waste generation related to the broader issues of pollution, resource use and conservation.
- An investigation into the environmental and ecological effects of visitor pressure on a local beauty spot.
- Evaluating the effects (e.g. on flora and fauna, soils etc) of a particular agricultural/woodland/conservation management practice.
- Urban air pollution studies through lichen analysis of walls.
- A case study of a particular environmental problem and its possible solutions.

Candidates should be guided to choose an investigation appropriate to their ability. Candidates should be aware that the coursework offers candidates from different cultural and ethnic backgrounds the opportunity to pursue particular interests which are appropriate to the specification.

13.2 Planning the Investigation

A plan of the proposed investigation should be submitted to the teacher before any actual practical work is done. The teacher can then check that the proposed investigation:

- is within the scope of the subject specification;
- is within the ability of the candidate;
- can be carried out safely;
- is likely to yield suitable results.

The plan should identify the aim/hypothesis and briefly describe an appropriate method using suitable apparatus, techniques, controls and replicates. Candidates should be aware that to achieve the highest marks they should include some justification of their choice of methods and materials.

The plan should identify the specification area(s) covered by the investigation.

If the investigation is suitable, then the teacher may give the candidate permission to proceed. If for some reason the method or design is not appropriate, the candidate should be offered the choice of trying again, without assistance, or accepting some help with a consequent lowering of the mark awarded.

The plan should form the first page of the final report and should contain written comments from the teacher to the candidate.

Plan sheets (see Appendix B) may be requested from AQA.

13.3 Presentation of Coursework

Length of Reports

This will vary according to the topic studied, but it is recommended that the completed piece of coursework should be approximately 2000 words in length. Headings, tables, diagrams, graphs, bibliography and appendices do **not** contribute to the basic word count. Candidates will not be penalised for exceeding the recommended length.

Method of Production

A4 paper must be used. Text and diagrams may be produced by hand, typed or word-processed (hard copy only). No preference will be given to any particular mode.

Candidates should write in an appropriate scientific style.

Maps, diagrams, graphs, photographs etc. should be used where relevant but they should all be folded to A4 size for presentation.

Lightweight folders with the contents loosely fixed are advised. Work must **not** be sent to the Moderator in plastic sleeves or bulky hard-backed folders/files.

Contents

These should include:

The plan sheet

Introduction

This should be a description of background information relevant to the study. Its purpose is to enable an intelligent reader to understand the nature of what was undertaken. It should include:

- brief reason(s) for the choice of topic;
- a description of the location(s) studied;
- a statement of the aims of the investigation including identification of the hypothesis/hypotheses to be tested or problem to be solved;
- brief summary of the information to be gathered.

Method

This should provide a full description of the methods and materials used to carry out the investigation such that it could be repeated accurately by another investigator. The choice of methods and apparatus used should be explained. Diagrams, annotated sketches and photographs may be used although it is not necessary to describe, photograph or draw common laboratory or fieldwork equipment.

Candidates should be encouraged to admit details of procedures that did not work, especially if it helps to explain how techniques/procedures evolved during the investigation. The method section should include an assessment of the risks and potential hazards that could be encountered in carrying out the investigation.

Results (Recording/Data Handling)

This should summarise any primary data collected in a form which is easy to understand. This will include tables, graphs, charts etc. and any numerical processing necessary to analyse and interpret the results. Evidence of the collection of primary data, in its original form, must also be submitted as appendices with the candidate's work. Any data used that was **not** collected by the candidate but used, for example, to strengthen an argument (i.e. from secondary sources) must be disclosed in both the Results and in the Bibliography / Acknowledgements sections.

Conclusion (Interpretation)

This section should contain a summary of the conclusions which can be drawn from the evidence collected. The conclusions should be related back to the original aim(s) or hypothesis/hypotheses described in the introduction and should consider the limitations of the investigation. All trends indicated by the results should be identified but care should be taken with generalisations.

Discussion

The conclusions should then be discussed in order to address the wider implications of the investigation and relate the findings to environmental problems and issues. Suggestions for the solution of such problems should be made and knowledge and awareness of attitudes and values must be demonstrated.

Evaluation

This should be a *post hoc* review of the whole investigation which should identify any difficulties encountered that might have affected the reliability of the results obtained. Suggestions should be made for ways to improve or extend the work in the light of experience.

Bibliography / Acknowledgement

Details must be given of any source materials used and *all* help received in any aspect of the investigation.

Appendix

This should contain the candidate's field notes, all raw data collected and any other material too marginal or too copious to include within the main body of the report.

13.4 Coursework Advisers

Coursework Advisers will be available to assist centres with any matters relating to coursework. Details will be provided when AQA knows which centres are following the specification.

Assessment Criteria

14.1 Introduction

Each candidate is assessed by the centre on his/her individual performance in each of **six** skill areas:

- Planning
- Implementation/Carrying out
- Recording and Data Handling
- Interpretation
- Evaluation
- Communication

Each skill is sub-divided into five sub-skills.

14.2 Criteria

Skill A: Planning

Candidates should show knowledge and understanding of basic fieldwork and laboratory techniques and demonstrate the ability to plan an investigation providing a reasoned explanation for the procedures selected.

Marks are awarded for:

- A1 A clear statement of the aims of the investigation together with a clearly worded and testable hypothesis.
- A2 A full discussion of background with no irrelevant material.
- A3 The method described in a series of well-ordered steps, giving sufficient detail for the work to be repeated by another person.
- A4 Appropriate selection of apparatus, equipment and techniques and justification for the choice of methods and materials.
- A5 The need for appropriate controls with identification of key variables and recognition of the contexts *e.g. fieldwork* where variables cannot be readily controlled.

Skill B: Implementation

Candidates should demonstrate the ability to carry out an investigation methodically using appropriate techniques and equipment safely and with skill. Candidates should be able to collect and record adequate relevant information with a degree of precision appropriate to the context.

Marks are awarded for

- B1 Safe working in the field* and a written risk assessment incorporated into the report.
- B2 A well organised and fully independent approach to carrying out the fieldwork*.

- B3 Use of equipment with precision and skill to obtain reliable and accurate evidence*.
- B4 Precision of measurements and/or observations which should be repeated where appropriate.
- B5 A full appreciation of the limitations of the methodology in producing reliable results.

[*Observed by supervisor/teacher]

Skill C: Recording and Data Handling

Candidates should demonstrate the ability to record evidence clearly and appropriately as they work and to select and present both qualitative and quantitative information using a variety of graphical methods. There should also be some evidence of simple numerical processing.

Marks are awarded for:

- C1 An adequate sample size/number of replicates.
- C2 Recording information in a clear and systematic way with well organised tables of raw data with units, clear headings etc.
- C3 Processing the data into a suitable form by use of tables, line-graphs, histograms, bar charts etc.
- C4 The use of calculations where appropriate (e.g. means, percentages etc.) to provide evidence for a conclusion.
- C5 Accuracy in numerical processing.

Skill D: Interpretation

Candidates should be able to analyse the evidence collected and draw valid conclusions based on the results of the investigation.

Marks are awarded for:

- D1 The identification of all trends and patterns (including anomalies).
- D2 Conclusions concisely stated and logically derived from results.
- D3 Conclusions drawn from results related to the aims/original hypothesis.
- D4 Full critical discussion of implications of the results.
- D5 Discussion of the results in relation to relevant scientific theory.

Skill E: Evaluation

Candidates should evaluate the outcome of an investigation by considering the reliability of the results and conclusions critically in relation to broader knowledge, understanding and appreciation of environmental issues. Candidates should propose improvements to the methods that have been used and suggest further investigation to test their conclusions. Appropriate solutions to environmental problems raised by the investigation may be suggested and candidates should show an awareness of attitudes and values involved in environmental issues.

Marks are awarded for:

- E1 Comment on the accuracy of the observations or measurements and the reliability of the evidence, accounting for any anomalous results.
- E2 Proposals for improvements/modifications to the methods used.
- E3 Suggestions for extensions to the study (closely related to the original investigation).
- E4 A full discussion of the environmental significance of the investigation showing a clear awareness of the interaction of physical, biotic and human influences.
- E5 Demonstration of a clear understanding of attitudes and values involved in environmental issues.

Skill F: Communication

Candidates should demonstrate the ability to produce a written report with accurate use of the rules of grammar, spelling and punctuation. The language of the report should be clear and written in standard scientific style with accurate use of scientific terminology. The report should be divided into sections as suggested in the ‘contents’ section.

Marks are awarded for:

- F1 Report written with clear and logical use of language.
- F2 Report set out in sections.
- F3 Good spelling, punctuation and grammar.
- F4 Report written in an appropriate and consistent style suited to the presentation of scientific information.
- F5 Use of correct scientific terminology.

14.3 Award of marks

Each of the 6 skills is therefore divided into 5 sub-skills A1, A2, A3 etc.

Each sub-skill to be awarded a maximum of **2 marks** as follows:

2 marks – Criterion fully met, achieves well.

1 mark – Criterion partially met, achieves limited success.

0 marks – Criterion not met, not worthy of credit or absent from the report.

Maximum mark = 60

14.4 Evidence to Support the Award of Marks

Teachers should keep records of their assessments during the course, in a form which facilitates the complete and accurate submission of the final assessments at the end of the course.

When the assessments are complete, the marks awarded under each of the assessment criteria must be entered on the Candidate Records Form, with supporting information given in the spaces provided. A specimen Candidate Record Form appears in Appendix B; the exact design may be modified before the operational version is issued and the correct year’s Candidate Record Forms should always be used.

15

Supervision and Authentication

15.1 Supervision of Candidates' Work

Candidates' work for assessment must be undertaken under conditions which allow the teacher to supervise the work and enable the work to be authenticated. If it is necessary for some assessed work to be done outside the centre, sufficient work must take place under direct supervision to allow the teacher to authenticate each candidate's whole work with confidence.

The precise means of maintaining supervision will inevitably differ from centre to centre and with the type of investigation chosen.

15.2 Guidance by the Teacher

The work assessed must be solely that of the candidate concerned. Any assistance given to an individual candidate which is beyond that given to the group as a whole must be recorded on the Candidate Record Form.

It is expected that the teacher will provide appropriate help and guidance on the selection of suitable and appropriate coursework.

The teacher should also provide periodic supervision, discussion and guidance to enable the coursework to be completed. The mark scheme takes into account how much help the candidate requires to produce adequate work.

15.3 Unfair Practice

At the start of the course, the supervising teacher is responsible for informing candidates of the AQA Regulations concerning malpractice. Candidates must not take part in any unfair practice in the preparation of coursework to be submitted for assessment, and must understand that to present material copied directly from books or other sources without acknowledgement will be regarded as deliberate deception. Centres must report suspected malpractice to AQA. The penalties for malpractice are set out in the AQA Regulations.

15.4 Authentication of Candidates' Work

Both the candidate and the teacher are required to sign declarations confirming that the work submitted for assessment is the candidate's own. The teacher declares that the work was conducted under the specified conditions, and records details of any additional assistance.

Candidates must produce original work which can be authenticated as being theirs alone. This does not preclude any group work where some data-pooling may occur but it should be stressed that the written work must be done by the candidate alone. Where group work has been carried out, the components of group and individual work must be clearly differentiated.

It is accepted that certain parts of candidate's research may be taken from other sources where these are relevant and appropriate. This is perfectly acceptable provided that all such uses are clearly identified in the text and all sources fully acknowledged.

15.5 Use of ICT

Centres offering courses based on this specification are encouraged to make candidates aware of the uses of appropriate information technology in conducting research and handling data. Centres must be fully aware from the onset of coursework if candidates are to use such techniques so that the work can be verified as the candidate's own. Candidates must declare on the *Coursework Cover Sheet* when they have used data generated by software. A candidate who uses a word processor or computer software will not for this reason gain more marks than a candidate who does not. Use of a word processor or computer software will be regarded only as an additional tool or technique and credit will be awarded only for how the data are used, classified and analysed. The data used by the candidate in any software program must be available for scrutiny by the Moderator along with other forms of the candidate's primary data.

16

Standardisation

16.1 Standardising Meetings

Annual standardising meetings will usually be held in the autumn term. Centres entering candidates for the first time must send a representative to the meetings. Attendance is also mandatory in the following cases:

- where there has been a serious misinterpretation of the specification requirements;
- where the nature of coursework tasks set by a centre has been inappropriate;
- where a significant adjustment has been made to a centre's marks in the previous year's examination.

After the first year, attendance is at the discretion of centres. At these meetings support will be provided for centres in the development of appropriate coursework tasks and assessment procedures.

16.2 Internal Standardisation of Marking

The centre is required to standardise the assessments across different teachers and teaching groups to ensure that all candidates at the centre have been judged against the same standards. If two or more teachers are involved in marking a component, one teacher must be designated as responsible for internal standardisation. Common pieces of work must be marked on a trial basis and differences between assessments discussed at a training session in which all teachers involved must participate. The teacher responsible for standardising the marking must ensure that the training includes the use of reference and archive materials such as work from a previous year or examples provided by AQA. The centre is required to send to the moderator the Centre Declaration Sheet, duly signed, to confirm that the marking of centre-assessed work at the centre has been standardised. If only one teacher has undertaken the marking, that person must sign this form.

A specimen Centre Declaration Sheet appears in Appendix B.

17

Administrative Procedures

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- 17.1 Recording Assessments** The candidates' work must be marked according to the assessment criteria set out in section 14. The marks and supporting information must be recorded in accordance with the instructions in Section 14. The completed Candidate Record Form for each candidate must be attached to the work and made available to AQA on request.
-
- 17.2 Submitting Marks and Sample Work for Moderation** The total component mark for each candidate must be submitted to AQA on the mark sheets provided or by Electronic Data Interchange (EDI) by the specified date. Centres will be informed which candidates' work is required in the samples to be submitted to the moderator.
-
- 17.3 Factors Affecting Individual Candidates** Teachers should be able to accommodate the occasional absence of candidates by ensuring that the opportunity is given for them to make up missed assessments.
- Special consideration should be requested for candidates whose work has been affected by illness or other exceptional circumstances. Information about the procedure is issued separately.
- If work is lost, AQA should be notified immediately of the date of the loss, how it occurred, and who was responsible for the loss. AQA will advise on the procedures to be followed in such cases.
- Where special help which goes beyond normal learning support is given, AQA must be informed so that such help can be taken into account when assessment and moderation take place.
- Candidates who move from one centre to another during the course sometimes present a problem for a scheme of internal assessment. Possible courses of action depend on the stage at which the move takes place. If the move occurs early in the course the new centre should take responsibility for assessment. If it occurs late in the course it may be possible to accept the assessments made at the previous centre. Centres should contact AQA at the earliest possible stage for advice about appropriate arrangements in individual cases.
-
- 17.4 Retaining Evidence and Re-Using Marks** The centre must retain the work of all candidates, with Candidate Record Form attached, under secure conditions, from the time it is assessed, to allow for the possibility of an enquiry upon results. The work may be returned to candidates after the issue of results provided that no enquiry upon result is to be made which will include re-moderation of the coursework component. If an enquiry upon result is to be made, the work must remain under secure conditions until requested by AQA.
- Candidates re-taking the examination may carry forward their moderated coursework marks. These marks have a shelf-life which is limited only by the shelf-life of the specification, and they may be carried forward an unlimited number of times within this shelf-life.
-

Moderation

18.1 Moderation Procedures

Moderation of the coursework is by inspection of a sample of candidates' work, sent by post from the centre to a moderator appointed by AQA. The centre marks must be submitted to AQA and the sample of work must reach the moderator by the specified date in the year in which the qualification is awarded.

Following the re-marking of the sample work, the moderator's marks are compared with the centre marks to determine whether any adjustment is needed in order to bring the centre's assessments into line with standards generally. In some cases it may be necessary for the moderator to call for the work of other candidates. In order to meet this possible request, centres must have available the coursework and Candidate Record Form of every candidate entered for the examination and be prepared to submit it on demand. Mark adjustments will normally preserve the centre's order of merit, but where major discrepancies are found, AQA reserves the right to alter the order of merit.

18.2 Post-Moderation Procedures

On publication of the GCSE results, the centre is supplied with details of the final marks for the coursework component.

The candidates' work is returned to the centre after the examination with a report form from the moderator giving feedback to the centre on the appropriateness of the tasks set, the accuracy of the assessments made, and the reasons for any adjustments to the marks.

Some candidates' work may be retained by AQA for archive purposes.

Awarding and Reporting

19

Grading, Shelf-Life and Re-Sits

19.1	Qualification Titles	The qualification based on this specification has the following title: AQA GCSE in Environmental Science.
19.2	Grading System	The qualification will be graded on an 8 point grade Scale A*, A, B, C, D, E, F, G. Candidates who fail to reach the minimum standard for grade G will be recorded as U (unclassified) and will not receive a qualification certificate. Candidates must be entered for either the Foundation Tier or Higher Tier. For candidates entered for the Foundation Tier, grades C–G are available. For candidates entered for the Higher Tier A*–D are available. There is a safety net for candidates entered for the Higher Tier, where an allowed Grade E will be awarded where candidates just fail to achieve Grade D. Candidates who fail to achieve a Grade E on the Higher Tier or Grade G on the Foundation Tier will be reported as unclassified.
19.3	Re-Sits	Individual components may not be retaken, but candidates may retake the whole qualification more than once.
19.4	Minimum Requirements	Candidates will be graded on the basis of work submitted for assessment.
19.5	Carrying Forward of Centre-Assessed Marks	Candidates re-taking the examination may carry forward their moderated coursework marks. These marks have a shelf-life which is limited only by the shelf-life of the specification, and they may be carried forward an unlimited number of times within this shelf-life.
19.6	Awarding and Reporting	This specification complies with the grading, awarding and certification requirements of the current GCSE, GCSE in vocational subjects, GCE, VCE, GNVQ and AEA Code of Practice 2006/7, and will be revised in the light of any subsequent changes for future years.

Appendices

A

Grade Descriptions

The following grade descriptors indicate the level of attainment characteristic of the given grade at GCSE. They give a general indication of the required learning outcomes at each specific grade. The descriptors should be interpreted in relation to the content outlined in the specification; they are not designed to define that content.

The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives (as in section 6) overall. Shortcomings in some aspects of the examination may be balanced by better performances in others.

Grade A Candidates recall a wide range of knowledge from all areas of the specification.

Candidates use detailed scientific knowledge and understanding in a range of applications relating to scientific systems or phenomena. For example, they explain the greenhouse effect in terms of wavelengths of incoming and outgoing radiation, demonstrate an understanding of links across the syllabus eg. explain that atmospheric pollutants can produce several different effects, explain eutrophication and its consequences. Candidates draw together and communicate knowledge from more than one area, use routinely scientific or mathematical conventions in support of arguments, use a wide range of scientific and technical vocabulary throughout their work.

Candidates explain how scientific theories can be changed by new evidence and identify some areas of uncertainty in science.

Candidates use scientific knowledge and understanding to select an appropriate strategy for a task, identifying the key factors to be considered. They make systematic observations in qualitative work and decide which observations are relevant to the task in hand. When making measurements they decide the level of precision needed and use a range of apparatus with precision and skill to make appropriately precise measurements. They select a method of presenting data appropriate to the task; they use information from a range of sources where it is appropriate to do so. They identify and explain anomalous observations and measurements and the salient features of graphs.

Candidates use scientific knowledge and understanding to identify and explain patterns and draw conclusions from the evidence by combining data of more than one kind or from more than one source. They identify shortcomings in the evidence, use scientific knowledge and understanding to draw conclusions from their evidence and suggest improvements to the methods used that would enable them to collect more reliable evidence.

Grade C Candidates recall a range of scientific information from all areas of the specification. For example, they describe the problems caused by CFCs. They demonstrate a simple understanding of the complexity of action of environmental factors such as air pollutants.

Candidates use and apply scientific knowledge and understanding in some general contexts, for example, use a balanced equation for photosynthesis, use quantitative relationships between physical quantities to perform calculations. Candidates describe links between related phenomena in different contexts, use diagrams, charts and graphs to support arguments, use appropriate scientific and technical vocabulary in a range of contexts.

Candidates describe how evidence is used to test predictions made from scientific theories, and how different people may have different views on some aspects of environmental science.

Candidates use scientific knowledge and understanding to identify an approach to a question, for example, identifying key factors to vary and control. Candidates use a range of apparatus to make careful and precise measurements and systematic observations and recognise when it is necessary to repeat measurements and observations. They present data systematically, in graphs where appropriate, and use lines of best fit. Candidates identify and explain patterns within data and draw conclusions consistent with the evidence. They explain these conclusions using scientific knowledge and understanding and evaluate how strongly their evidence supports the conclusions.

Grade F Candidates recall a limited range of information. For example, they suggest ways in which insulation is used in domestic contexts, use the word equation for photosynthesis.

Candidates use and apply knowledge and understanding in some specific everyday contexts. For example, they describe how a reduction in the population of one organism in a habitat can affect another organism, describe some harmful as well as beneficial effects of pesticides, describe some of the harmful environmental effects of industries such as power generation. Candidates make some use of scientific and technical vocabulary and make simple generalisations from information.

Candidates relate scientific explanations to some experimental evidence and describe simple examples of benefits and drawbacks of scientific development. Candidates are aware that actions taken to mitigate environmental damage need to balance environmental benefit against social or economic factors eg. carbon dioxide emissions cannot be stopped.

Candidates devise fair tests in contexts, which involve only a few factors. They use simple apparatus to make measurements appropriate to the task and record observations and measurements in tables and graphs. Candidates obtain information from simple tables, charts and graphs and identify simple patterns in information and observations. They offer explanations consistent with the evidence obtained.

B

Record Forms



Centre-assessed work Centre Declaration Sheet 2008

Qualification: ELC GCSE GCE GNVQ FSMQ Key Skills

Specification title: Unit code(s):

Centre name: Centre no:

Authentication of candidates' work

This is to certify that marks/assessments have been given in accordance with the requirements of the specification and that every reasonable step has been taken to ensure that the work presented is that of the candidates named.

Any assistance given to candidates beyond that given to the class as a whole and beyond that described in the specification has been recorded on the *Candidate Record Form(s)* and has been taken into account. The marks/assessments given reflect accurately the unaided achievement of the candidates.

Signature(s) of teacher(s) responsible for assessment

Teacher 1: Teacher 4:
 Teacher 2: Teacher 5:
 Teacher 3: Teacher 6:

(continue overleaf if necessary)

Internal standardisation of marking

Each centre must standardise assessment across different teachers/assessors and teaching groups to ensure that all candidates at the centre have been judged against the same standards.

If two or more teachers/assessors are involved in marking/assessing, one of them must be designated as responsible for standardising the assessments of all teachers/assessors at the centre.

I confirm that [tick either (a) or (b)]

- (a) the procedure described in the specification has been followed at this centre to ensure that the assessments are of the same standard for all candidates; or
- (b) I have marked/assessed the work of all candidates.

Signed: Date:

Signature of Head of Centre: Date:

This form should be completed and sent to the moderator with the sample of centre-assessed work



Centre-assessed work Candidate Record Form 2008

GCSE Environmental Science 3441

Centre name:

Centre no:

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Candidate name:

Candidate no:

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This side is to be completed by the candidate

Sources of advice and information

1. Have you received any help or information from anyone other than your subject teacher(s) in the production of this work? (Write YES or NO)

2. If you have answered YES, give details below. Continue on a separate sheet if necessary.

.....

3. If you have used any books, information leaflets or other materials (e.g. videos, software packages or information from the Internet) to help you complete this work, you must list these below, unless they are clearly acknowledged in the work itself. To present material copied from books or other sources without acknowledgement will be regarded as deliberate deception.

.....

.....

NOTICE TO CANDIDATE

The work you submit for assessment must be your own.

If you copy from someone else or allow another candidate to copy from you, or if you cheat in any other way, you may be disqualified from at least the subject concerned.

Declaration by candidate

I have read and understood the Notice to Candidate (above). I have produced the attached work without any help apart from that which I have stated on this sheet.

As part of AQA's commitment to assist students, AQA may make your coursework available on a strictly anonymous basis to teachers, examining staff and students in paper form or electronically, through the Internet or other means, for the purpose of indicating a typical mark or for other educational purposes. In the unlikely event that your coursework is made available for the purposes stated above, you may object to this at any time and we will remove the work on reasonable notice. If you have any concerns, please contact crf@aqa.org.uk

Candidate's signature:

Date:

This form should be completed and attached to the candidate's work and retained at the Centre or sent to the moderator as required.

PTO

This side to be completed by the teacher

Marks must be awarded in accordance with the instructions and criteria in section 14 of the specification.

Supporting information to show how the marks have been awarded should be given in the form of annotations on the candidate's work and in the spaces below.

Assessment criteria (enter the best mark for each)		Max. mark	Mark awarded	Teacher's supporting statement
Skill A: Planning	A1	2		
	A2	2		
	A3	2		
	A4	2		
	A5	2		
Skill B: Implementation	B1	2		
	B2	2		
	B3	2		
	B4	2		
	B5	2		
Skill C: Recording and data handling	C1	2		
	C2	2		
	C3	2		
	C4	2		
	C5	2		
Skill D: Interpretation	D1	2		
	D2	2		
	D3	2		
	D4	2		
	D5	2		
Skill E: Evaluation	E1	2		
	E2	2		
	E3	2		
	E4	2		
	E5	2		
Skill F: Communication	F1	2		
	F2	2		
	F3	2		
	F4	2		
	F5	2		
Total mark		60		

Details of additional assistance given (if any)

Record here details of any assistance given to this candidate which is beyond that given to the class as a whole and beyond that described in the specification. Continue on a separate sheet if necessary.

Teacher's signature: Date:



Centre-assessed work Plan Sheet 2008

GCSE Environmental Science 3441

This sheet should be completed by the candidate before starting the Practical Investigation and submitted to the teacher for approval. The completed sheet should be attached to the Report.

Centre name:

Centre no:

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Candidate name:

Candidate no:

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This side is to be completed by the candidate

Investigation title

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Aim or hypothesis

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Brief description of method including apparatus, techniques, controls and replicates

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PTO

Overlaps with Other Qualifications

GCSE Sciences:
(GCSE Science A,
GCSE Science B,
GCSE Additional Science,
GCSE Biology,
GCSE Chemistry,
GCSE Physics)

Some topics within the Environmental Science specification can be found in part in the GCSE Sciences.

However the approach, breadth and depth of coverage of these topics may vary considerably.

GCSE Human Physiology and Health

There is a degree of overlap in the following topics:

- water - effects of fertilisers;
- water treatment;
- sewage treatment;
- respiration;
- food chains and webs;
- selective breeding;
- recycling of materials;
- refuse disposal.

However, the emphasis and approach to each topic varies between the specifications.