SCQF level 6
Unit Specification

Environmental Science: Sustainability

SCQF: level 6 (6 SCQF credit points)

Unit code: J266 76

Unit outline

The general aim of this Unit is to develop skills of scientific inquiry, investigation and analytical thinking and independent working, along with knowledge and understanding of sustainability. Learners will apply these skills when considering the applications of sustainability on our lives, as well as the implications on society and the environment. This can be done by using a variety of approaches, including investigation and problem solving.

The Unit covers the key areas of global challenges; food; water; energy; waste management; anthropogenic climate change.

Learners will research issues, apply scientific skills and communicate information related to their findings, which will develop skills of scientific literacy.

Learners who complete this Unit will be able to:

1 Apply skills of scientific inquiry and draw on knowledge and understanding of the key areas of this Unit to carry out an experiment/practical investigation

2 Draw on knowledge and understanding of the key areas of this Unit and apply scientific skills

This Unit is available as a free-standing Unit. The Unit Specification should be read in conjunction with the *Unit Support Notes*, which provide advice and guidance on delivery, assessment approaches and development of skills for learning, skills for life and skills for work. Exemplification of the standards in this Unit is given in Unit Assessment Support.

Recommended entry

Entry to this Unit is at the discretion of the centre. However, learners would normally be expected to have attained the skills, knowledge and understanding required by one or more of the following or equivalent qualifications and/or experience:

- National 5 Environmental Science Course or relevant component Units
- National 5 Geography Course or relevant component Units
- National 5 Biology or relevant component Units

In terms of prior learning, relevant experiences and outcomes may also provide an appropriate basis for doing this Unit.

Equality and inclusion

This Unit Specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence. For further information, please refer to the *Unit Support Notes.*

Standards

Outcomes and assessment standards

Outcome 1

The learner will:

1 Apply skills of scientific inquiry and draw on knowledge and understanding of the key areas of this Unit to carry out an experiment/practical investigation by:

1.1 Planning an experiment/practical investigation
1.2 Following procedures safely
1.3 Making and recording observations/measurements correctly
1.4 Presenting results in an appropriate format
1.5 Drawing valid conclusions
1.6 Evaluating experimental procedures

Outcome 2

The learner will:

2 Draw on knowledge and understanding of the key areas of this Unit and apply scientific skills by:

2.1 Making accurate statements
2.2 Solving problems

Evidence Requirements for the Unit

Assessors should use their professional judgement, subject knowledge and experience, and understanding of their learners, to determine the most appropriate ways to generate evidence and the conditions and contexts in which they are used.

The key areas covered in this Unit are:

- global challenges
- food
- water
- energy
- waste management
- anthropogenic climate change

The *Unit Support Notes* (Appendix) provide details of skills, knowledge and understanding sampled in the Unit assessment.

The following table describes the evidence for the Assessment Standards.

Assessment Standard	Evidence required
Planning an experiment or practical investigation	A plan that must include: ♦ a clear statement of the aim ♦ a dependent and independent variable ♦ variables to be kept constant ♦ observations and/or measurements to be made ♦ necessary equipment and/or materials ♦ a clear and detailed description of how the experiment or practical investigation should be carried out, including safety considerations
Following procedures safely	Record showing that the learner was observed following procedures safely.
Making and recording observations/measurements correctly	Raw data recorded in a relevant format, for example a table. Repeated measurements, where appropriate. Where measurements are repeated, averages must be calculated.
Presenting results in an appropriate format	One format from: line graph, bar graph, scatter graph or other appropriate format
Drawing a valid conclusion	A conclusion that includes reference to the aim, and is supported by the data.
Evaluating experimental procedures	Two evaluative statements, with justifications, about the procedures used.
Making accurate statements and solving problems	Achievement of at least 50% of the total marks available in a holistic assessment. The assessment must **not** be split into smaller sections, such as individual key areas.

Exemplification of assessment is provided in *Unit Assessment Support*.

Assessment Standards thresholds

Outcome 1
Learners are not required to show full mastery of the Assessment Standards to achieve Outcome 1. Instead, five out of the six Assessment Standards for Outcome 1 must be met to achieve a pass. Learners must be given the opportunity to meet all Assessment Standards.

Outcome 2
Learners are assessed using a holistic test that covers Assessment Standards 2.1 and 2.2. To gain a pass for Outcome 2, learners must achieve 50% or more of the total marks available in the assessment.

Transfer of evidence

Evidence for the achievement of Outcome 1 for this Unit can be used as evidence of Outcome 1 in the SCQF level 6 Units: *Environmental Science: Living Environment* (J261 76) and *Environmental Science: Earth's Resources* (J264 76).

Evidence for the achievement of Outcome 2 for this Unit is **not** transferable between the SCQF level 6 Units: *Environmental Science: Living Environment* (J261 76) and *Environmental Science: Earth's Resources* (J264 76).

Re-assessment

SQA's guidance on re-assessment is that there should be only one or, in exceptional circumstances, two re-assessment opportunities. Re-assessment must be carried out under the same conditions as the original assessment and must be of equal demand.

Outcome 1
Learners can either re-draft their original Outcome 1 report or carry out a new experiment/practical investigation.

Outcome 2
Learners must have a full re-assessment opportunity that consists of a holistic assessment. For Outcome 2, learners must achieve 50% of the total marks available in the re-assessment.

Development of skills for learning, skills for life and skills for work

It is expected that learners will develop broad, generic skills through this Unit. The skills that learners will be expected to improve on and develop through the Unit are based on SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work* and drawn from the main skills areas listed below. These must be built into the Unit where there are appropriate opportunities.

1 Literacy

1.2 Writing

2 Numeracy

2.1 Number processes
2.2 Money, time and measurement
2.3 Information handling

4 Employability, enterprise and citizenship

4.6 Citizenship

5 Thinking skills

5.3 Applying
5.4 Analysing and evaluating
5.5 Creating

Amplification of these is given in SQA's *Skills Framework: Skills for Learning, Skills for Life and Skills for Work.* The level of these skills should be at the same SCQF level of the Unit and be consistent with the SCQF level descriptor. Further information on building in skills for learning, skills for life and skills for work is given in the *Unit Support Notes.*

Appendix: Unit Support Notes

Introduction

These support notes provide advice and guidance on developing skills, knowledge and understanding for the Unit assessment. They should be read in conjunction with:

- *Unit Assessment Support*

Developing skills, knowledge and understanding

Teachers and lecturers are free to select the skills, knowledge and understanding, and contexts that are most appropriate for delivery in their centres.

Skills, knowledge and understanding for the Unit assessment

The following information provides details of skills, knowledge and understanding sampled in the Unit assessment.

Sustainability

The focus of this topic should be on the environmental, economic, and social components of sustainability, and the relationship between these. These should be considered with regard to developed and developing countries.

1 Global challenges

Learners should be familiar with the definitions of the following terms, and be able to use them appropriately:

Energy security, food security, water security

This list is not exhaustive, and terms listed here may apply in more than one area.

a. Demand for global resources

- **Food**
  Increasing population; changes in consumer demand; changes brought about by development and climatic change

- **Water**
  Increasing population; increasing demand by agriculture and industry; changes brought about by development and climatic change

- **Energy**
  Increasing population; changes in consumer demand; increasing demand by transportation, domestic, agriculture, industry; and changes brought about by development and climatic change

b. Security of access to food, water, and energy

- **Food**
  Access, quantity, and quality.

- **Water**
  Areas of the world that are most likely to experience water insecurity are places with low rainfall, or rapid population growth in a freshwater scarce area, or areas with international competition over water sources, or combinations of these.

- **Energy**
  Access to 'cheap' energy has become essential to the functioning of modern economies, but the uneven distribution of energy supplies among countries has led to significant vulnerabilities.

2 Food

Learners should be familiar with the definitions of the following terms, and be able to use them appropriately:

Agrochemicals, algal bloom, aquaculture, bioaccumulation, biological oxygen demand (BOD), biomagnification, crop rotation, diversification, eutrophication, genetic modification (GM), high yield varieties, hydroponics, intensive agriculture, marginal land, mechanisation, metabolisation, nutrient enrichment, persistent organic compounds (POPs), pollutant, selective breeding, sustainability, sustainable development, trophic level

This list is not exhaustive, and terms listed here may apply in more than one area.

Strategies to increase global food production

- **Development of intensive agriculture**
  Changes in land management: larger fields, crop rotation, drainage, hedgerow removal, cultivation of marginal land, conservation practices, diversification

- **Changes in technology**
  Mechanisation, agrochemicals (fertilisers, pesticides), irrigation, selective breeding, high yield varieties, GM crops, hydroponics

- **Aquatic food production**
  — aquaculture: high density cages, pesticide use, selective breeding, GM, hormone use

  — marine fisheries: stock management

- **Impacts of intensive food production**
  — use of nitrate-based and phosphate-based fertilisers, and pesticides.

  Nitrates and phosphates absorbed by plants are used for growth. The use of chemical fertilisers and phosphate-based detergents has greatly increased the levels of nitrates and phosphates entering waterbodies. These cause nutrient enrichment of the water, known as eutrophication, which enhances aquatic plant growth.

  Algae in nutrient-enriched water undergo a population explosion, which is referred to as an algal bloom. As the bloom spreads across the water surface, light and oxygen are prevented from penetrating the water, which affects aquatic life. When the algae and aquatic organisms die, they are decomposed by bacteria, increasing the BOD of the waterbody. At the same time, the decomposition process releases more nitrates and phosphates into the water, causing further eutrophication.

  Pesticides belong to a group of chemicals known as persistent organic pollutants (POPs), which are compounds that are resistant to environmental degradation.

Pesticides applied in fields can enter waterbodies, where they are absorbed by aquatic invertebrates through their skin, gills, or lungs. The pollutant is stored in the tissues of the organism at a rate faster than it can be metabolised or excreted, a process known as bioaccumulation. This does not cause much damage at lower trophic levels.

As a consumer eats more contaminated prey, the level of pollutant gradually builds up in its tissues. This predator will in turn be consumed as prey, and the concentration of the pollutant will increase as it is passed up the food chain, eventually reaching toxic levels. The dietary uptake of the pollutant and its movement through trophic levels is known as biomagnification. This causes significant harm to organisms in the higher trophic levels, such as impairment of the immune and reproductive system.

3 Water

Learners should be familiar with the definitions of the following terms, and be able to use them appropriately:

Anaerobic digestion, biogas, biological oxidation, blackwater, coagulation, desalination, disinfection, drip irrigation, effluent, filtration, floc, flocculation, greywater, pathogen, purification, screening, sedimentation, sewage liquor, sewage sludge

This list is not exhaustive, and terms listed here may apply in more than one area.

a. Sustainable management of water resources

- **Desalination**
  Including reasons for desalination. A knowledge of methods of desalination is not required.

- **Water conservation methods in agriculture and industry**
  - Agriculture: drip irrigation, drought-resistant crops
  - Industry: modification of processes, replacement of equipment, reuse of greywater and blackwater

b. Improving water quality

- **Methods used to improve water quality**
  The water purification process has multiple stages. Developed countries tend to follow the full process but developing countries may use a much reduced programme, depending on resources.

  Methods:
  - Screening, to remove larger pieces of debris from surface water.
  - Coagulation and flocculation involve the addition of a coagulant chemical that causes smaller particles to clump together, forming floc.

— Sedimentation, to allow the floc to settle out as sludge.

— Filtration, to remove bacteria, parasites and remaining suspended particles. Methods used in developed and developing countries are to be included.

— Disinfection, to kill pathogens. Methods used in developed and developing countries are to be included.

c. Sewage treatment

- **Methods used in sewage treatment**
  - — Preliminary treatment: screening to remove bulky solids, and grit removal.
  - — Primary treatment: sedimentation to remove remaining solids. Produces sludge and liquor; sludge is removed and treated, and liquor passes to the next stage.
  - — Secondary treatment: biological oxidation using micro-organisms and aeration removes dissolved and suspended organic matter. Sludge is removed and treated, liquor passes to the next stage.
  - — Tertiary treatment: filtration, to remove remaining suspended matter and toxins from the liquor, which is now known as effluent.
  - — Discharge of effluent to river or sea.
  - — End uses of sewage sludge: heat-treated and used as fertiliser; turned into sludge cake and used for energy generation through incineration; anaerobic digestion to generate biogas, used for heat and electricity generation.

4 Energy

Learners should be familiar with the definitions of the following terms, and be able to use them appropriately:

Catalyst, electrolysis, fission, fracking, fuel cell, gasification, hydrogen power, pyrolysis, shale gas, steam methane reforming

This list is not exhaustive, and terms listed here may apply in more than one area.

a. Shale gas

- **Extraction of shale gas** — fracking
- **Benefits and challenges of extraction of shale gas**

b. Hydrogen power

- **Sources**
  Natural gas, coal, water, biomass

- **Energy production from these sources**
  Steam methane reforming, gasification, pyrolysis, electrolysis

  Steam methane reforming involves the reaction of natural gas with steam in the presence of a catalyst to produce hydrogen and carbon.

  Gasification or pyrolysis of coal or biomass produces a mix of hydrogen and carbon monoxide.

  Electrolysis involves the splitting of water molecules into hydrogen and oxygen using electricity and an electrolyser device (fuel cell).

- **Advantages and disadvantages of using hydrogen as a fuel**

c. Nuclear Energy

- **Source**
  Uranium ore

- **Production — fission**
  Fission is the main process used for generating nuclear energy, and involves splitting of atoms to release energy which can then be harnessed.

  Uranium-235 (^{235}U) is used in the fission process as its atoms have relatively large nuclei that are easy to split.

  When ^{235}U undergoes fission, the nucleus splits into two smaller nuclei plus a few neutrons, releasing heat energy and gamma radiation. The neutrons hit other uranium nuclei and cause them to split, causing a chain reaction. The chain reaction must be controlled in a nuclear reactor to stop it going too fast. In a nuclear power station, the energy released through fission is used to heat water and generate steam, which turns turbines and generates electrical power.

- **Advantages and disadvantages of nuclear power generation**

5 Waste management

Learners should be familiar with the definitions of the following terms, and be able to use them appropriately:

Circular economy, closed loop recycling, energy recovery, food use-by date, incineration, landfill, life cycle analysis, linear economy, obsolescence, open loop recycling, planned obsolescence, psychological obsolescence, technological obsolescence, waste disposal, waste hierarchy, waste prevention, waste recovery, waste recycling, waste reuse

This list is not exhaustive, and terms listed here may apply in more than one area.

a. Life cycle analysis (LCA)

- **Purpose**
  LCA examines the total environmental impact of a product through every step of its life, from obtaining raw materials to disposal. It is a systematic process, identifying and quantifying all inputs (materials, energy, fuels) and outputs (products, waste, emissions) for a whole life cycle or for individual stages. Manufacturers can then evaluate the results and consider where change might be made.

- **Circular and linear economic models**
  The circular economy has been devised as an alternative to the 'take, make, dispose' nature of the linear model, as a solution to waste generation.

b. Waste generation

- **Globalisation of supply chains**

- **Obsolescence**
  Technological, planned, psychological

- **Packaging**
  Packaging is used to facilitate transport and storage of products to protect them from damage. It is used to display products such as food and technological gadgets. Packaging protects against unnecessary waste but is itself considered waste.

  Pressure from government and society is forcing the packaging industry to consider how its products can be made more sustainable. In addition to reducing the volume of packaging, focus is on use of renewable energy in sourcing, manufacturing, transporting and recycling processes; use of renewable or recycled source materials; and amending production practices.

c. Waste hierarchy

- **Purpose**
  Ranks waste management options according to what is best for the environment.

- **Prevention**
  Using less material in design and manufacture; keeping products for longer; reuse; using less hazardous materials; improved quality control and process monitoring, food use-by dates and impact on food waste, education.

- **Preparation for reuse**
  Checking, cleaning, repairing, refurbishing, whole items or spare parts.

- **Recycling**
  Turning waste into a new substance or product, including composting.

  Open loop and closed loop recycling
  In open loop recycling, a loss of quality often occurs with each recycling cycle, limiting the number of times the material can be recycled. An example is plastic, which is reprocessed into a lower grade product each time. Eventually it will not be recyclable and will become waste.

  In closed loop recycling, a product can be recycled indefinitely back into itself without any impact on its quality. An example is aluminium. Recycling aluminium requires approximately 5% of the energy needed to produce it from bauxite, reducing waste, resource depletion, and anthropogenic greenhouse gas emissions.

- **Recovery of energy and materials from waste**

- **Disposal — landfill and incineration without energy recovery**

d. Impact of waste on the environment
Impacts on air quality; water quality; landscape, including the marine environment; biodiversity; climate change.

6 Anthropogenic climate change
Learners should be familiar with the definitions of the following terms, and be able to use them appropriately:

Anthropogenic, anthropogenic greenhouse gas, climate change, desertification, enhanced greenhouse effect, global warming, greenhouse gas, sea level, soil stability, weather

This list is not exhaustive, and terms listed here may apply in more than one area.

a. Anthropogenic greenhouse gases
Carbon dioxide, methane, nitrous oxide, water vapour

- **Sources**
  Learners must know two sources of each of the anthropogenic greenhouse gases.

b. Impacts of global warming and climate change
— changes in weather patterns; snow and ice cover; soil stability, including desertification; sea level, and ocean currents.

— impacts on ecosystems, species distribution, and biodiversity; and on food production.

c. Minimising the impacts of anthropogenic climate change
Appraisal of sustainable strategies at individual, local, national, and international levels

Apparatus and techniques

In addition to the skills, knowledge and understanding listed above, learners must have knowledge of the following pieces of apparatus and techniques. Where it is not possible to carry out a fieldwork technique, learners should be made aware of the purpose and methodology of the technique through teaching.

Apparatus

- beaker
- measuring cylinder
- dropper/pipette
- test tube
- stopwatch
- funnel
- crucible
- oven
- thermometer

Techniques

- interpreting case study documentary evidence, including Ordnance Survey map content, sketch maps, photographic evidence, tabular data, and/or short passages of text. The ability to read and provide grid references is not required.

Reporting experimental and/or fieldwork

Learners should be familiar with the following:

- setting an aim and/or hypothesis
- selecting information: quantitative and qualitative, discrete and continuous
- planning, designing and undertaking experimental/fieldwork procedures safely
- summarising experimental/fieldwork procedures
- drawing labelled diagrams of experimental/fieldwork apparatus
- presenting data in tabular form, with appropriate headings and units of measurement
- presenting data in graphical form: bar graph, line graph, scatter graph, or other graphical form appropriate to environmental science, with appropriate scales, labels, keys and units, and including a line of best fit (straight or curved) if appropriate, to represent the trend observed in experimental/fieldwork data
- processing data (using calculations and units, where appropriate)
- comparing and/or analysing data sets
- drawing valid conclusions from the data and giving explanations supported by evidence/justification, and related to the aim
- evaluating experimental/fieldwork procedures and suggesting and justifying improvements
- citing and referencing sources of data/information

Calculations

Learners should be familiar with the following methods of calculation:

- measures of average: mean, median
- measures of spread: standard deviation, interquartile range
- ratio
- percentage increase and decrease
- calculations involving number substitution in formulae

Administrative information

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Superclass: QA

History of changes to National Unit Specification

Version	Description of change	Authorised by	Date
2.0	Page 1 – the description of key areas under 'Unit outline' has been revised to give more information Page 3 – in Outcome 1.3, the word 'accurately' has been replaced by 'correctly'; the Evidence requirements have been rewritten to better explain what is required, and information has been added on Transfer of Evidence	Qualifications Development Manager	April 2014
3.0	Assessment Standards 2.2 & 2.3 removed	Qualifications Development Manager	June 2014
3.1	Assessment standard thresholds added	Qualifications Manager	September 2018
4.0	Unit code updated	Qualifications Manager	July 2019
5.0	Refined guidance on Evidence Requirements; removed option for assessment-standard-specific evidence for Outcome 2. Added 'Assessment Standards thresholds' heading to existing information. Refined guidance on re-assessment. Some changes made to the format throughout the document to improve accessibility. Required knowledge, understanding, and skills added to the unit support notes. **What you need to do differently** ♦ If you are already assessing outcome 2 holistically at the end of the unit, by using the assessment as a single test	Qualifications Manager	August 2025

Version	Description of change	Authorised by	Date
	with marks and a cut-off score, you don't need to do anything differently. ♦ If you have been assessing outcome 2 atomistically, by assessing each key area and each problem-solving skill separately, you must change to using the holistic approach for outcome 2. You must do this by administering the test in a single sitting, at the end of the unit, and applying the marks and cut-off score in the unit assessment support pack.		