Unit 8: Understanding Principles of Physical and Biological Environmental Processes

Unit code: A/600/9437

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to introduce learners to a knowledge of environmental processes and how this can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education. Those employed in managing and conserving the countryside must have a knowledge and understanding of environmental processes and the environmental impacts of human activities. The learner will study how physical and biological processes maintain life on Earth and how humans affect them. They will study environmental systems of the earth-atmosphere, lithosphere, biosphere and hydrosphere.

Unit introduction

With both physical and biological environmental processes becoming increasingly important and with issues such as energy usage, climate change and sustainability at the forefront of the public's concern, it is vital that we become informed about such processes and the impact that they could have on both us and future generations.

The natural world is complex and human actions can have unexpected consequences that are hard to reverse. The study of how physical and biological processes maintain life, and how humans affect nature, requires a broad interdisciplinary perspective.

Those employed in managing and conserving the countryside must have a knowledge and understanding of environmental processes and the environmental impacts of human activities.

Learning outcomes

On completion of this unit a learner should:

1 Understand the scientific principles and processes that influence energy transfer and the atmosphere as part of the earth-atmosphere system

2 Understand the physical and biological processes within the lithosphere

3 Understand the physical and biological processes within the biosphere

4 Know how water is used and managed within the hydrosphere.

Unit content

1 Understand the scientific principles and processes that influence energy transfer and the atmosphere as part of the earth-atmosphere system

Energy laws: first and second laws of thermodynamics; energy properties; different forms of energy

Energy transfer: insolation and re-radiated energy; albedo (absorption and scattering of radiation in the troposphere and at the Earth's surface); greenhouse effect; shielding effect of ozone in the stratosphere; seasonal variations in insolation (associated variations in day-length and climate); human activity – energy use and conservation (different energy sources, national and global trends in energy demand, renewable and non-renewable energy sources eg fossil fuels, nuclear fission, solar, hydroelectric, wind, wave, geothermal, tidal)

Climate principles and processes: influence of continentality, ocean currents, atmospheric circulation; link between temperature variations and movement in air and water; the climate of the British Isles (reasons for the variations in temperature and precipitation across the islands); microclimates due to natural surface features eg vegetation, water bodies, ground cover and topographic features; temperature inversions; urban heat islands

2 Understand the physical and biological processes within the lithosphere

Rocks: origins and characteristics of the major rock types (igneous, sedimentary, metamorphic); the rock cycle; biogeochemical cycles; physical, chemical and biological processes and reservoirs associated with the carbon, nitrogen and phosphorous cycles

Soil composition and formation: soil composition (sand, silt, clay, air, water, living organisms, organic matter); soil formation stages (weathering, humification and chelation, organic sorting, translocation and aggregation)

Soil distribution: main soil types found in the British Isles (podsol, brown-earth, rendzina, gley soil, peat); use and management of soils; effect of human activity; sources and demand for rocks as aggregates of minerals; methods of exploiting mineral deposits eg open-cast mining, quarrying; processes involved in the extraction of metal minerals (eg extraction, chemical reduction, refining, metal alloying); environmental impacts of mineral extraction activities (open-cast mining, shaft mining, quarrying and dredging)

3 Understand the physical and biological processes within the biosphere

Life processes: conditions for supporting life on Earth (water, temperature, radiation and gases); food webs; factors affecting the rate of photosynthesis and the link to plant growth and yield; the concept of limiting factors; plant adaptations to variations in temperature and water availability; aerobic and anaerobic respiration; absorption and assimilation of food by animals (heterotrophs); energy transfer; the carbon and nitrogen cycles as examples of circulation and the need to maintain balance; effects of life processes on the atmosphere and lithosphere

4 Know how water is used and managed within the hydrosphere

The hydrological cycle: processes involved (precipitation, interception, infiltration, utilisation, transpiration, evaporation, surface run-off, through flow, groundwater and water storage); the physical and chemical properties of water; effects of climate change on water availability and use; relationship between demand and supply and water quality; availability of water (abstraction, treatment and distribution); effects of increased water consumption eg on the water table, aquifer storage, wildlife; the problems associated with agricultural and industrial pollution eg eutrophication, increased biological oxygen demand, direct toxicity; causes and effects; scientific methods of monitoring pollution and water quality; the role of environmental public bodies eg Environment and Heritage Service (Northern Ireland), Environment Agency (England and Wales)

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria					
To achieve a pass grade the evidence must show that the learner is able to:		**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**		**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**	
P1	explain the scientific principles and processes that influence the climate in the earth-atmosphere system [IE1]	**M1**	summarise the factors that influence the climate of the British Isles	**D1**	discuss the effects of human activity on the atmosphere and lithosphere
P2	explain the scientific principles and processes that influence the transfer of energy in the earth-atmosphere system [IE1]				
P3	explain the origins and characteristics of rocks [RL2; EP3]	**M2**	explain the origins and characteristics of rocks and soils found in a selected area		
P4	explain factors affecting soil composition and formation [RL2; IE3]				
P5	outline the distribution of selected soil types found in the British Isles [RL2; SM2; EP1]				
P6	explain the processes involved in photosynthesis, respiration, energy transfer and the carbon and nitrogen cycles [CT1; IE1; SM1]	**M3**	explain how plant and animal processes affect the atmosphere and lithosphere	**D2**	explain how a knowledge of scientific processes can influence husbandry and management strategies.
P7	describe the physical and chemical properties of water [CT1; IE1; SM1]	**M4**	explain the importance of the hydrological cycle.		
P8	outline the processes involved in the hydrological cycle. [CT2; IE2; SM3]				

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised fieldwork and laboratory practicals, internet and/or library-based research and personal and/or industrial experience would all be suitable.

Where used to support delivery, work placements should be monitored regularly to ensure the quality of the learning experience. It would be beneficial if learners and supervisors were made aware of the requirements of this unit before any work-related activities take place so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to participate in the collection of environmental data. Assessors should complete observation records and/or witness statements to confirm learner achievement. Guidance on the use of observation records and witness statements is provided on the Edexcel website (www.edexcel.com).

Health and safety issues relating to any practical microclimate investigation or any fieldwork must be raised and regularly reinforced, and risk assessments must be undertaken before practical activities take place, for example fieldwork or site visits. Adequate personal protective equipment (PPE) must be provided and used following the production of suitable risk assessments.

Tutors should consider integrating the delivery, private study and assessment for this unit with other relevant units and assessment instruments that learners are taking as part of their programme of study.

Visiting expert speakers could add to the relevance of the subject. For example, a farmer or crop grower, a fisheries or scientific officer from the Environment Agency or Environment and Heritage Service could talk about their work, the situations they face and the methods they use.

For learning outcome 1, learners will look at the scientific principles and processes that influence energy transfer and the atmosphere as part of the earth-atmosphere system. This is likely to be delivered through classroom sessions, site visits, fieldwork practicals and independent learner research.

Learning outcome 2 covers the physical and biological processes associated with the lithosphere. Delivery techniques should comprise a mix of classroom sessions, discussions, site visits, fieldwork, laboratory practicals and independent learner research.

Learning outcome 3 deals with the physical and biological processes within the biosphere. Learners will become aware of the range of plant adaptations to environmental variations. Delivery techniques could include lectures, discussions, site visits, fieldwork, laboratory practicals and independent library and internet research.

For learning outcome 4, learners will investigate the use and management of water within the hydrosphere. This learning outcome is likely to be delivered through classroom activity, discussion, site visits, fieldwork, laboratory practicals and independent learner research. Delivery should include coverage of the scientific methods and associated activities commonly used to determine pollution levels in rivers and other water bodies.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and assessment
Introduction and overview of the unit.
Assignment 1: It's Raining (P1, P2, M1) Tutor introduces the assignment brief.
Classroom session – energy laws and energy transfer.
Learner research and presentations – factors affecting climate.
Classroom activity – climate of the British Isles and factors affecting it.
Classroom activity – effects of human activity on climate and energy.
Learner research and assessment completion.
Assignment 2: Solid as a Rock (P3, P4, P5, M2, D1) Tutor introduces the assignment brief.
Classroom session – the lithosphere, origins of rocks, examine rock samples.
Laboratory session – experiments to investigate soil types.
Group activity – distribution of soils within the British Isles.
Field trip to examine rocks and soils in the locality.
Learner research and assessment completion.
Assignment 3: Water, Water Everywhere (P7, P8, M4) Tutor introduces the assignment brief.
Theory session – hydrological cycle and properties of water.
Laboratory session – properties of water.
Visit to see one part of hydrological cycle, eg reservoir, river catchment.
Guest speaker – managing water pollution.
Learner research and assessment completion.
Assignment 4: Keep on Cycling (P6, M3, D2) Tutor introduces the assignment brief.
Theory session – photosynthesis and respiration.
Laboratory practicals – experiments for photosynthesis and respiration.
Classroom activity – carbon and nitrogen cycles.
Theory session – energy transfer.
Classroom activity and case study – using knowledge of science to influence husbandry and management.
Learner research and assessment completion.
Unit review and evaluation.

Assessment

For P1 and P2, learners need to explain the scientific processes and principles that influence the transfer of energy (P2) and the climate (P1) in the Earth's atmospheric system. This could be presented in a written assignment, or through a verbal presentation, supported by an assessor's observation record.

For P3 and P4, learners need to explain the origins and characteristics of rocks (P3) and explain factors affecting soil composition and formation (P4). Learners need to include the range of factors shown in the *Unit content*. Evidence may be a verbal or written report or leaflet.

For P5, learners need to outline the distribution of selected soil types found in the British Isles. The major soil types shown in the *Unit content* should be covered. Evidence may be via an illustrated article or report.

For P6, learners need to explain the processes of photosynthesis, respiration, energy transfer and the carbon and nitrogen cycles. Evidence could be a written or verbal report, which may be linked to laboratory practicals.

For P7, learners need to describe the physical and chemical properties of water. Evidence may take the form of a leaflet or report, and may be linked to evidence presented for P8.

For P8, learners need to outline the processes of the hydrological cycle. This could be presented as a leaflet, article or illustrated report and may be linked to P7.

For M1, learners need to summarise the factors that influence the climate of the British Isles. This could be presented verbally with an accompanying leaflet or audio visual presentation. If a presentation is selected as the assessment method, tutors must complete appropriate documentation (observation records, witness statements) to confirm learners' achievement.

For M2, learners need to explain the origins and characteristics of rocks and soils found in a selected area. This requires learners to apply and extend the information presented in P3 and P4. This could be assessed practically on a field visit, or through a verbal or written report.

For M3, learners need to extend evidence presented for P6 and explain how plant and animal life processes affect both the atmosphere and the lithosphere. This explanation should include both positive and detrimental effects, and may be in the same format as for P6.

For M4, learners need to explain the importance of the hydrological cycle. This should include the importance of each stage of the cycle and the factors affecting it. Evidence may be an extension of that provided for P7 and P8 and presented in the same format.

For D1, learners need to discuss the effects of human activity on the atmosphere and the lithosphere. This could include positive and detrimental effects at local and global levels. Evidence could be a verbal or written report, presentation or scientific article.

For D2, learners need to explain how a knowledge of scientific processes (ie those included in P6 and P8, M3 and M4) can influence husbandry and management strategies. This should include examples of where the scientific knowledge affects practice, eg in improving plant and animal growth rates, soil fertility and water availability. Evidence may be a report or presentation (supported by an assessor's observation record to confirm learners' achievement).

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1	It's Raining	You are a researcher for a television company that is planning a series to help the public understand about science. You have been asked to produce a script for the presenter which explains the scientific principles and processes that influence the transfer of energy and climate in the Earth's atmosphere system. Use a summary of the factors that influence the climate of the British Isles to help to illustrate the principles.	Report or presentation. Observation record.
P3, P4, P5, M2, D1	Solid as a Rock	You are working for the Environment Agency and have been asked to lead a series of field trips for A-level students. Create a guidance leaflet which includes the origins and characteristics of rocks, factors which affect soil composition and formation and the distribution of soil types in the British Isles. Explain how this relates to the origins and characteristics of rocks and soils found locally. Prepare notes for a talk to the students where you plan to discuss the effects of human activity on the lithosphere and atmosphere.	Guidance leaflet. Discussion notes.
P7, P8, M4	Water, Water Everywhere	The Environment Agency has asked for your help in designing an information panel for display by a reservoir. They would like it to include the physical and chemical properties of water, the processes involved in the hydrological cycle and its importance in the supply of clean water.	Information leaflet.
P6, M3, D2	Keep on Cycling	You have been asked to write an article for a publication promoting the benefits of science as a career. Your article should include an explanation of how a knowledge of scientific processes helps husbandry and management. Include an explanation of plant and animal processes, and how they affect the atmosphere and lithosphere.	Report/article. Practical assessment. Observation record.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Land-based sector suite. This unit has particular links with the following units in the BTEC Land-based suite and the BTEC Environmental Sustainability suite:

Level 2	Level 3
Conservation and Improvement of British Habitats	Understanding the Principles of Wildlife Populations, Ecology and Conservation
Undertaking Ecological Surveys and Techniques	Understand the Principles of Plant Science
Introduction to Environmental Studies	Understand the Principles of Soil Science
	Science for Environmental Technicians
	Informatics for Environmental and Sustainability Industries

Essential resources

For this unit, it is essential that learners have access to a well-stocked, up-to-date resource centre with internet and computer availability. It is also important that learners visit the local area to assess soil and rock composition and the effects of human activity.

Employer engagement and vocational contexts

Learners can be introduced to a variety of professionals, such as geologists and environmental scientists, from different companies and organisations to broaden their knowledge and make the learning experience interesting and contextualised. This could be done by either guest lectures or off-site visits to different establishments. All sites should be checked for health and safety prior to visits.

Indicative reading for learners

Textbooks

Ashman M and Puri G – *Essential Soil Science* (Blackwell, 2002) ISBN 9780632048854

Barnes C, Poole N and Poore N – *Plant Science in Action* (Hodder Arnold, 1994) ISBN 9780340600993

Barry R and Chorley R – *Atmosphere, Weather and Climate, Eighth Edition* (Taylor & Francis, 2003) ISBN 9780415271714

Boyle G – *Renewable Energy, Second Edition* (Oxford University Press, 2004) ISBN 9780199261789

Byrne K, Corscadden T and Genn R – *Environmental Science, Second Edition* (Nelson Thornes, 2001) ISBN 9780174483052

Cunningham W, Cunningham M and Saigo B – *Environmental Science: A Global Concern* (McGraw-Hill Higher Education, 2004) ISBN 9780071111126

Keating J, Crane R and Kump L – *The Earth System: An Introduction to Earth Systems Science, Second Edition* (Prentice Hall, 2003) ISBN 9780131420595

Lenon B and Cleves P – *Fieldwork Techniques and Projects in Geography, Second Edition* (HarperCollins Publishers, 2001) ISBN 97800071144 29

Porteous A – *Dictionary of Environmental Science and Technology, Fourth Edition* (Wiley-Blackwell, 2000) ISBN 9780471634706

Smithson P, Addison K and Atkinson K – *Fundamentals of the Physical Environment, Third Edition* (Taylor & Francis, 2002) ISBN 9780415232944

Wilson E – *The Diversity of Life* (Penguin Books, 2001) ISBN 9780140291612

Journals

Nature

New Scientist

Websites

Department for Environment, Food and Rural Affairs	www.defra.gov.uk
Environment Agency	www.environment-agency.gov.uk
Health and Safety Executive	www.hse.gov.uk
Lantra Sector Skills Council	www.lantra.co.uk
National Geographic	www.nationalgeographic.com
Northern Ireland Environment Agency	www.ni-environment./gov.uk

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	exploring principles of physical and biological processes
Creative thinkers	exploring the processes involved in photosynthesis, respiration, energy transfer and the carbon and nitrogen cycles
Reflective learners	considering the origins and characteristics of rocks
Self-managers	organising time and resources when investigating the hydrological cycle
Effective participators	proposing practical ways forward in the exploration of soil types.

Functional skills – Level 2

Skill	When learners are ...
ICT – finding and selecting information	
Use appropriate search techniques to locate and select relevant information	researching data to explore the effects of human activity on climate and the environment
Select information from a variety of sources to meet requirements of a complex task	researching data and information on factors affecting climate
ICT – developing, presenting and communicating information	
Enter, develop and refine information using appropriate software to meet requirements of a complex task	producing a guidance leaflet covering origins and characteristics of rocks, factors affecting soil composition and formation, and distribution of soil types in the British Isles
Combine and present information in ways that are fit for purpose and audience	designing presentations covering physical and biological environmental processes producing a guidance leaflet designing presentations preparing notes to discuss effects of human activity on the lithosphere and atmosphere
English – Speaking, Listening and Communication	
Make a range of contributions to discussions in a range of contexts, including those that are unfamiliar, and make effective presentations	discussing effects of human activity on the lithosphere and atmosphere undertaking laboratory practical experiments covering photosynthesis and respiration
English – Reading	
Select, read, understand and compare texts and use them to gather information, ideas, arguments and opinions	using case studies to research plant and animal processes and effects on the atmosphere
English – Writing	
Write a range of texts, including extended written documents, communicating information, ideas and opinions, effectively and persuasively	producing reports on the scientific principles and processes that influence the transfer of energy and climate producing an information leaflet on the properties of water.