Higher National Unit Specification

General information

Unit title: Environmental Chemistry: An Introduction (SCQF level 7)

Unit code: HV9W 34

Superclass: QA

Publication date: November 2017

Source: Scottish Qualifications Authority

Version: 02

Unit purpose

This unit is designed to enable learners to understand key chemical principles integral to understanding environmental and biological systems. Learners will also develop practical skills in a range of applied chemical techniques relevant to environmental chemistry. The unit is suitable for learners studying at HNC/HND level, and will provide the necessary underpinning knowledge and skills to enable progression to further study in an area related to environmental science at degree level or to seek employment in science based industries.

Outcomes

On completion of the unit the learner will be able to:

1 Describe key chemical principles (organic and inorganic) in natural systems: land, water and air.
2 Perform experimental techniques applicable to environmental chemistry.

Credit points and level

1 Higher National Unit credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

Recommended entry to the unit

While entry is at the discretion of the centre, it would be an advantage if learners had attained the following, or equivalent:

- Chemistry at National 5 or equivalent.

Higher National Unit Specification (cont)

General information

Core Skills

Achievement of this Unit gives automatic certification of the following Core Skills component:

Complete Core Skill None

Core Skill component Critical Thinking at SCQF level 5

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit specification.

Context for delivery

If this unit is delivered as part of a group award, it is recommended that it should be taught and assessed within the subject area of the group award to which it contributes.

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.

Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**.

Higher National Unit Specification: Statement of standards

Unit title: Environmental Chemistry: An Introduction (SCQF level 7)

Acceptable performance in this unit will be the satisfactory achievement of the standards set out in this part of the unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Outcome 1

Describe key chemical principles (organic and inorganic) in natural systems: land, water and air.

Knowledge and/or skills

- The hydrosphere and water chemistry
- The atmosphere and atmospheric chemistry
- Nature and properties of soil (chemical reactions and interactions with water and air)
- Environmental Biochemistry

Outcome 2

Perform experimental techniques applicable to environmental chemistry.

Knowledge and/or skills

- Environmental chemistry experiments
- Working safely, within current health and safety regulations
- Consistent and accurate results
- Recording observations and results
- Data analysis, interpretation and conclusions

Evidence requirements for this unit

Written and/or oral recorded evidence for Outcome 1 should be assessed using a holistic open-book assessment under supervised conditions with a 60% cut-off for a pass of the learning outcome. It is recommended that the assessment be completed within 60 minutes.

Outcome 1

The assessment will assess all of the knowledge and/or skills items. A learner's response will be judged satisfactory where the evidence shows that the learner can:

- describe the chemical composition of the hydrosphere (water chemistry).
- describe oxidation/reduction in an aquatic environment.
- describe aquatic microbial biochemistry.
- describe the chemical characteristics of the atmosphere (atmospheric chemistry).
- describe particles, organic and inorganic air pollutants (atmospheric chemical reactions).
- describe the nature and chemical properties of soil.
- describe oxidation/reduction in a soil environment.
- describe the biosphere: Environmental Biochemistry.

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Outcome 2

Learners will perform a minimum of two practical experiments, the content of which will be related to Outcome 1. Learners must report one of the two practical experiments by completion of an appropriate pro forma. A learner's response will be judged satisfactory where the evidence shows that the learner can achieve all of the following:

- Follow instructions to perform experiments related to environmental chemistry.
- Work in a safe manner regarding current health and safety regulations.
- Achieve consistent and accurate results.
- Record experimental observations and results clearly and accurately.
- Summarise data in appropriate illustrative format (i.e. graphical with description of trends).
- Describe relation of results to studied environmental issue and identify potential sources of bias.

Where a submitted pro forma does not meet required standard, then the learner will be given a single opportunity to re-draft. If the required standard is still not attained, they will be given the chance to undertake a different practical experiment.

Higher National Unit Support Notes

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Unit support notes are offered as guidance and are not mandatory.

While the exact time allocated to this unit is at the discretion of the centre, the notional design length is 40 hours.

Guidance on the content and context for this unit

This unit is part of the framework for HNC/HND Environmental Resource Management, but may be suitable for inclusion in other HN Science awards. It is designed to develop the theoretical and practical aspects of environmental chemistry and to introduce learners to theories that are specific to the environment.

Outcome 1 — Describe key chemical principles (organic and inorganic) in natural systems: land, water and air.

- Aquatic chemistry, organic pollutants and biological interactions.
- Chemical properties and reactions in the atmosphere to include oxidation/reduction.
- The nature and properties of soils to include minerals, macro and micronutrients, and chemical reactions to include cation exchange capacity and oxidation/reduction.
- Environmental biochemistry to include an introduction to xenobiotics (ie PCBs/Dioxins).

Outcome 2 — Perform experimental techniques applicable to environmental chemistry.

Guidance on suitable practical experiments for assessment purposes is given within the guidance on approaches to delivery section of this descriptor. However, it is envisaged that learners will participate in at least two practical experiments which will both develop their laboratory skills and support the theory covered in Outcome 1.

In carrying out such activities, learners should follow Good Laboratory Practice (GLP) and carry out or be familiar with the risk and Control of Substances Hazardous to Health (COSHH) assessments on all procedures undertaken. Opportunities should be taken to develop awareness of the sources of experimental error and of the accuracy of measurements, with quantification of errors where possible. Illustration of results supported by a description of trends should be undertaken with results interpreted in relation to the environmental issue assessed (ie impacts of waterlogging of soils or effects of milk additions to water oxygen availability).

Higher National Unit Support Notes (cont)

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Guidance on approaches to delivery of this unit

There is no particular order in which Outcomes 1 and 2 would be best delivered. It is envisaged that laboratory work and demonstrations will feature across the delivery of each of the outcomes, and that the assessed practical experiments for Outcome 2 will be undertaken in similar timeframe to the underpinning theory.

It is envisaged that the delivery of Outcome 1 could commence with coverage of the importance of the atmosphere and the chemical characteristics of the atmosphere, including atmospheric composition, primary and secondary pollutants (chemical reactions). In the study of chemical and biochemical reactions taking place it is important that learners should understand in detail the formation processes and common interactions of oxygen, nitrogen, carbon dioxide and atmospheric vapour.

The theories of environmental chemistry of water could commence with the properties of water (polarity and composition), including alkalinity and acidity, metal ions in water, water hardness, oxidation and reduction reactions in water, interactions with aquatic life, bacteria in water, microbial transformations in water, salinity of water, oxygen, and pollutants (ie organic matter and biological oxygen demand as a chemical reaction).

The theories of environmental chemistry of land should include the nature of soils to include mineral ions, physical and chemical aspects of the weathering process, and properties of soil including: inorganic components of soil, organic matter in soil and acid/base and ion exchange reactions in soil. Cation exchange capacity and isotopes should be included.

Environmental biochemistry should cover reactions and transport of chemical species in the air, water and soil and may include mention of PCBs, Dioxins or DDT as common examples.

It is envisaged that Outcome 2 will be delivered alongside the theoretical based Outcome 1. A range of practical experiments could be utilised to both support the understanding of the theory and to prepare learners for undertaking the assessed practical experiments. Aspects suitable for experimental investigation might include; alkalinity of water, hardness of water, pH measurement, suspended solid, pH of soil, metal content in soil (redox reactions of iron), air sampling techniques, and dust particles in air.

Guidance on approaches to assessment of this unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Outcome 1 could be assessed by a single holistic open-book assessment with an appropriate cut-off score of 70% to pass the outcome. Assessment could be carried out in supervised conditions, and it is recommended that the assessment be completed within 60 minutes. This assessment could be delivered as an online e-assessment.

Higher National Unit Support Notes (cont)

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In Outcome 2 learners are required to undertake at least two laboratory sessions with one of these an assessed practical experiment using a provided report pro forma, the content of which will be related to Outcome 1. Examples of suitable experiments are given below. However, this list is not prescriptive, and other practical experiments of similar complexity may be used by the centre.

- alkalinity of water
- hardness of water
- pH measurement
- suspended solid
- pH of soil
- oxidation reaction (i.e. Iron)
- metal content in soil
- dust particles in air

An assessor observation checklist could be used to record the learner's performance of the practical work in line with given instructions and health and safety requirements.

Assessed practical experiments will usually be performed individually. However, there may be some experiments that are suitable to be undertaken in pairs or small groups. If this is the case then the assessor should ensure that all participants are actively involved and are able to adequately demonstrate the required skills.

While aspects of Outcome 1 could be delivered by distance learning, the practical nature of Outcome 2 would make this more difficult. Attendance for a laboratory programme would be required.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the evidence requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at **www.sqa.org.uk/e-assessment.**

Opportunities for developing Core and other essential skills

This Unit has the Critical Thinking component of Problem Solving embedded in it. This means that when learners achieve the Unit, their Core Skills profile will also be updated to show they have achieved Critical Thinking at SCQF level 5.

The delivery and assessment of this unit will provide learners with the further opportunity to develop the Core Skills of *Numeracy* and *Problem Solving* at SCQF level 6, and *Information and Communication Technology (ICT)* at SCQF level 4.

Higher National Unit Support Notes (cont)

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Numeracy — Using Number at SCQF level 6

Learners will be required to decide on the steps and operations to solve complex problems, carrying out sustained and complex calculations.

Problem Solving — Reviewing and Evaluating at SCQF level 6

Following assessed practical experiments learners will be required to review and evaluate the effectiveness of the exercise with a thorough interpretation of random and systematic sources of error. They will be required to reach sound conclusions on the basis of the data collected and the inherent errors.

Information and Communication Technology (ICT) — Providing/Creating Information at SCQF level 4

Learners could make effective and appropriate use of *ICT* packages to produce laboratory reports or pro formas in an appropriate format. Packages used will likely include word processing, spreadsheets and specialist chemical structure software. Learners will also be required to utilise internet search engines to source information on research topics.

Sustainability

Sustainability can be embedded in delivery of the unit in a variety of ways. For example, by encouraging minimum usage, correct disposal procedures and possibly recycling (eg of solvents) during practical experiments.

History of changes to unit

Version	Description of change	Date
02	Core Skills Component Critical Thinking at SCQF level 5 embedded.	24/11/2017

General information for learners

Unit title: Environmental Chemistry: An Introduction (SCQF level 7)

This section will help you decide whether this is the unit for you by explaining what the unit is about, what you should know or be able to do before you start, what you will need to do during the unit and opportunities for further learning and employment.

This is a 1 credit unit at SCQF level 7, which you are likely to be studying as part of the second year of an HND in Environmental Resource Management. Before progressing to this unit it would be beneficial to have some background in Chemistry (such as Standard Grade or equivalent), where you will have learned underpinning aspects of environmental chemistry and developed practical skills but this is not essential. There will be a strong emphasis on the importance of experimental data in understanding chemical principles, and on the applications of chemical knowledge in practical situations. There is strong link between this unit and the *Monitoring and Analytical Methods for Environmental Science* unit (F5T6 35).

On completion of the unit you will be able to:
1 Describe key chemical principles (organic and inorganic) in natural systems: land, water and air.
2 Perform experimental techniques applicable to environmental chemistry.

Outcome 1

In this outcome you will cover the chemical characteristics (inorganic and organic) of the atmosphere, reactions of atmospheric oxygen, nitrogen and carbon dioxide, reactions of atmospheric water and atmospheric particles, the properties of water, aquatic biochemistry and aquatic chemistry.

You will also cover aspects of the nature and properties of soil to include minerals, macro and micronutrients, soil pH, redox reactions, isotopes and cation exchange capacity.

Outcome 2

In this outcome you will undertake practical experiments, based on the content of outcomes 1. During this practical work, you will also be expected to develop good laboratory practices as well as improve your skills of manipulation, observation and measurement. You will be encouraged to develop safe working practices and to strive constantly to improve the accuracy and reliability of your results. The reporting and analysis of experimental data is an important aspect of the practical sessions.

Assessment

For Outcome 1 you could take an end of unit assessment (could be provided as an online assessment). You will be required to achieve 60% in this assessment to gain a pass. Outcome 2 will be assessed after you have learned the necessary practical skills, and will take the form of two practical experiments, for which you will present your results by completion of a pro forma report for one.

Core Skills

This Unit has the Critical Thinking component of Problem Solving embedded in it. This means that when you achieve the Unit, your Core Skills profile will also be updated to show you have achieved Critical Thinking at SCQF level 5. You will also have opportunities to develop the Core Skills of *Numeracy* and *Problem Solving* at SCQF level 6, and *Information and Communication Technology (ICT)* at SCQF level 4.