National Unit specification: general information

Unit title: Water Industry Applied Science (SCQF Level 5)

Unit code: FY9V 11

Superclass: TL

Publication date: November 2011

Source: Scottish Qualifications Authority

Version: 02

Summary

The purpose of this Unit is to provide candidates with an opportunity to develop their knowledge and understanding of how the fundamental principles of physics and chemistry are applied within the operations and practices of the water industry. Candidates will also develop knowledge and understanding of the role of plastics and quality standards within the industry. Candidates will apply mathematical calculations in the context of water industry practices.

This is a mandatory Unit within the National Progression Award in Water Operations: An Introduction at SCQF level 5.

This Unit is suitable for candidates who have recently joined the water industry as an apprentice or at a similar level.

Outcomes

1 Demonstrate knowledge and understanding of the fundamental principles of physics in the context of applications within the water industry.
2 Demonstrate knowledge and understanding of the fundamental principles of chemistry in the context of applications within water and waste water.
3 Describe the properties and use of plastics within the water industry.
4 Perform mathematical calculations applicable to practices within the water industry.
5 Identify the role of quality standards in relation to drinking water and waste water.

Recommended entry

Entry is at the discretion of the centre. Candidates doing this Unit do not need any prior knowledge or experience of the water industry. However, good skills in all five Core Skills and some scientific experience would be advantageous.

General information (cont)

Unit title: Water Industry Applied Science (SCQF Level 5)

Credit points and level

1.5 National Unit credit(s) at SCQF level 5: (9 SCQF credit points at SCQF level 5*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

Core Skills

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

- Using Number 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.

National Unit specification: statement of standards

Unit title: Water Industry Applied Science (SCQF Level 5)

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

Demonstrate knowledge and understanding of the fundamental principles of physics in the context of applications within the water industry.

Performance Criteria

(a) Acurrately define the terms relating to the fundamental concepts of: heat; mechanics; electricity; and magnetism.
(b) List and accurately describe applications of each term identified in (a) in relation to practices within the water industry.
(c) Explain the impact of each term identified in (a) for specific applications in the water industry.
(d) Define the concepts of density; specific gravity and capillarity in terms of practical applications within the water industry.

Outcome 2

Demonstrate knowledge and understanding of the fundamental principles of chemistry in the context of applications within water and waste water.

Performance Criteria

(a) Describes the chemical reactions, chemicals used, and products produced during coagulation, flocculation, disinfection and final treatment of drinking water.
(b) Clearly and accurately define the term hardness in drinking water is clearly defined.
(c) Describe correctly the effects that hardness in water can create and how hardness can be removed or reduced.
(d) Correctly define and describe the pH scale.
(e) Describe correctly the terms electrolytic and bacterial corrosion and two main methods of corrosion protection.
(f) Accurately describe the process of desalination

National Unit specification: statement of standards (cont)

Unit title: Water Industry Applied Science (SCQF Level 5)

Outcome 3

Describe the properties and use of plastics within the water industry.

Performance Criteria

(a) Describe correctly the principles of polymerisation and the structure of simple polymers in general terms.
(b) Define thermosetting and thermoplastic polymers in general terms.
(c) State the main differences between thermosetting and thermoplastic polymers.
(d) Describe the use of polymers within the water industry in general terms.

Outcome 4

Perform mathematical calculations applicable to practices within the water industry.

Performance Criteria

(a) Perform simple calculations in the context of water industry applications involving addition, subtraction, multiplication and division.
(b) In the context of water industry applications calculate areas and volumes of circles, cylinders, rectangular or square objects; proportions and ratios.
(c) In the context of water industry applications perform calculations using Pythagoras' Theorem; powers and indices; simple linear equations and transposition of formulae.
(d) State Ohm's law and perform calculations to accurately determine resistance, voltage drop, current flowing and power consumed in a practical circuit.
(e) Accurately perform simple calculations involving heat capacity accurately.
(f) Calculate accurately the magnitude of a moment forces applied by levers using the Theorem of Moments.
(g) Accurately perform simple calculations involving work, work done and conservation of energy.

Outcome 5

Identify the role of quality standards in relation to drinking water and waste water.

Performance Criteria

(a) List at least one parameter from the physical, chemical and biological categories of the drinking water standards and state the maximum permitted value for each parameter.
(b) Describe the significance of the maximum permitted value of each parameter listed in terms of health or operations of a drinking water undertaking or company.
(c) State and describe accurately the significance of the three main parameters used to measure waste water quality providing typical values for each.
(d) State who enforces drinking water and waste water standards and accurately describe how the process is implemented.

National Unit specification: statement of standards (cont)

Unit title: Water Industry Applied Science (SCQF Level 5)

Evidence Requirements for this Unit

Evidence is required to demonstrate that candidates have achieved all Outcomes and Performance Criteria.

Written, oral, diagrammatical or electronic form of evidence should be produced to demonstrate that the candidate has achieved all of the Outcomes and Performance Criteria. The evidence should be produced under supervised conditions to a given brief.

Outcome 1 — Written and/or Oral Evidence

The evidence for this Outcome must be obtained under controlled, supervised conditions. The assessment will be closed-book and refer to at least two applications per term.

Candidates must provide evidence of the following principles of physics:

Heat

- heat as a form of energy and Units used to measure it
- temperature measurement
- heat transfer: conduction, convection, radiation
- expansion of solids, liquids, gases
- specific heat, heat capacity, latent heat, change of state
- anomalous expansion of water

Electricity and Magnetism

- Units, current, potential difference, E.M.F, resistance,
- sources of electrical energy, three main methods.
- Units to measure power
- direct and alternating current
- electromagnetic induction, solenoids, electric motors, generators by means of sketches and diagrams
- simple primary and secondary cells, electrical energy and power

Mechanics

- force, vectors, forces in equilibrium, resolution of forces
- moments of a force, levers, providing at least one example
- work, work done, conservation of energy
- mechanical advantage, and machines

Density; Specific Gravity and Capillarity

- concept of density and the practical application of it
- concept of specific gravity and the practical application of it
- capillarity and the practical implications of it

National Unit specification: statement of standards (cont)

Unit title: Water Industry Applied Science (SCQF Level 5)

Outcome 2 — Written and/or Oral Evidence

The evidence for this Outcome must be obtained under controlled, supervised conditions. The assessment will be closed-book, and refer to at least two applications per term.

Candidates must provide evidence of the following principles of chemistry:

- simple treatment of the chemical reactions involved in the chemical treatment of water, including coagulation, flocculation, disinfection and final treatment
- hardness in drinking water; pH values
- introduction to electrolytic corrosion and bacterial corrosion and methods of prevention
- desalination

Outcome 3 — Written and/or Oral Evidence

The evidence for this Outcome must be obtained under controlled, supervised conditions. The assessment will be closed-book and refer to at least two applications per term.

Candidates must provide evidence of the following properties of plastics:

- structure of simple polymers
- thermosetting and thermoplastic polymers
- properties of main types of plastics used in the water industry

Outcome 4 — Performance Evidence

The evidence for this Outcome must be obtained under controlled, supervised conditions. The assessment will be closed-book.

Candidates must provide evidence of competence in performing mathematical calculations in:

- addition, subtraction, multiplication and division mensuration
- volumes of circles, cylinders, rectangular or square objects
- proportion and ratios
- pythagoras
- powers and indices.
- linear equations
- transposition of formulae
- Ohm's law and resistance, voltage drop, current flowing and power consumed in a practical circuit
- heat capacity
- Theorem of Moments
- work, work done and conservation of energy

National Unit specification: statement of standards (cont)

Unit title: Water Industry Applied Science (SCQF Level 5)

Outcome 5 — Performance evidence

The evidence for this Outcome must be obtained under controlled, supervised conditions. The assessment will be closed-book.

Candidates must provide evidence of competence in identifying the role of quality standards in the following terms:

- measures of drinking water quality
- significance of water quality parameters
- measures of waste water quality
- significance of waste water quality parameters
- practical application of water and waste water quality

Note — all Outcomes can be assessed individually or with a holistic approach.

National Unit specification: support notes

Unit title: Water Industry Applied Science (SCQF Level 5)

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 60 hours.

Guidance on the content and context for this Unit

This Unit is a mandatory Unit within the National Progression Award in Water Operations: An Introduction at SCQF level 5, but can also be taken as a free-standing Unit.

This Unit is a knowledge based Unit which relates to the whole industry and as such does not align to a specific National Occupational Standards Unit.

In this Unit candidates are required to develop their knowledge and understanding of how the fundamental principles of physics and chemistry are applied within the operations and practices of the water industry. They will learn about the fundamental principles of physics, chemistry and plastics in the context of the water industry. How to apply mathematical calculations in scientific formulas within water related applications. Identify the role of quality standards within the industry.

Guidance on learning and teaching approaches for this Unit

For Outcomes 1, 2 and 3 candidates would benefit from working as a class to develop collectively the fundamentals of each subject area and through working in small groups to task specific exercises designed in the context of the water industry.

Industrial visits will be an advantage to highlight the context of the subject.

For Outcome 4 the candidates will benefit from working individually on specifically designed exercises in the context of the water industry, and supported by one-to-one tuition.

Outcome 5 would be well supported by the provision of real examples of quality standards and the benefits in industry, through the use of real case studies and industrial visits.

National Unit specification: support notes (cont)

Unit title: Water Industry Applied Science (SCQF Level 5)

Guidance on approaches to assessment for this Unit

The following approaches to assessment are suggested:

Outcome 1: Closed-book exam, with a series of short restricted response questions addressing the following:

Concepts:

- define heat as a form of energy and state the various Units used to measure it
- describe how temperature can be measured and the difference between heat and temperature
- list and describe how heat can be transferred
- explain the effects of heat in relation to the expansion of solids liquids and gases
- explain the practical implications of the expansion of solids liquids and gases and perform simple calculations of expansion
- define specific heat and latent heat and give some practical examples in relation to water
- define heat capacity and do some simple calculations involving it accurately
- describe the anomalous expansion of water and the practical implications of it

Terminology and methods:

- define the terms, current, potential difference, E.M.F, resistance, and the Units used to specify them
- describe the three main methods and principles which can be used to produce electrical energy and state the formula and the Units used to measure power
- state Ohm's law and perform calculations to determine resistance, voltage drop, current flowing and power consumed in a practical circuit, accurately
- define direct and alternating current
- explain the principles of electromagnetic induction, solenoids, electric motors, generators by means of sketches and diagrams
- explain the principles of simple primary and secondary cells

Applications:

- define what is meant by a force, state the Units which are used to measure it and explain what is meant by a vector
- define what is meant by forces in equilibrium and give at least one example
- define what is meant by resolution of forces and give at least one practical example
- state the Theorem of Moments and calculate the magnitude of a moment accurately
- describe examples of the practical application of the Theorem of Moments with reference to levers and calculate forces applied by levers, accurately
- define the terms work, work done and conservation of energy and do some simple calculations involving them, accurately
- define the term mechanical advantage and give some simple examples of machines which utilise such

National Unit specification: support notes (cont)

Unit title: Water Industry Applied Science (SCQF Level 5)

Outcome 2: Closed-book exam, with a series of short restricted response questions addressing the following:

- describe the chemical reactions, chemicals used, and products produced during coagulation, flocculation, disinfection and final treatment of drinking water
- define what is meant by hardness in drinking water, name and describe the two main types of hardness in drinking water.
- describe the effects that hardness in water can create and indicate how hardness can be removed or reduced
- define and describe the pH scale, how pH is measured and the importance of the value of pH to water treatment and supply
- define and describe electrolytic and bacterial corrosion and describe at least two main methods of corrosion protection
- define and describe desalination and indicate at least two methods by which desalination can be effected

Outcome 3: Closed-book exam with structured questions covering:

- structure of simple polymers
- thermosetting and thermoplastic polymers
- properties of main types of plastics used in the Water Industry

Outcome 4: Series of performance related tasks, project-based or investigative, where the candidate demonstrates competence in:

- performing simple calculations involving addition, subtraction, multiplication and division
- calculating areas and volumes of circles, cylinders, rectangular or square objects
- calculating proportions and ratios
- explaining Pythagoras Theorem and perform calculations using it
- explaining the concept of powers and indices and performing calculations involving them
- performing calculations using simple linear equations
- transposing the subject of a formula correctly

Outcome 5: Closed-book exam with structured questions or project-based task covering role of quality standards in relation to drinking water and waste water.

Opportunities for the use of 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 candidate evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. Further advice is available in *SQA Guidelines on Online Assessment for Further Education (AA1641, March 2003), SQA Guidelines on e-assessment for Schools (BD2625, June 2005)*.

National Unit specification: support notes (cont)

Unit title: Water Industry Applied Science (SCQF Level 5)

Opportunities for developing Core Skills

The purpose of this Unit is to provide candidates with the knowledge and understanding of the key aspects of the water supply, and candidates will be provided the opportunity to develop the following Core Skills:

Communication — both Oral and Written

- small group working, discussion
- verbal and written instructions
- written responses to wide range of questioning techniques

Problem Solving — Critical Thinking; Planning and Organising; Reviewing and Evaluating

- applying knowledge and understanding to a series of practical and research based assignments on the fundamentals of physics and chemistry
- completing assignments through effective planning and organising within groups and individually

Information and Communication Technology — Accessing and Processing Information

- conducting research
- using technology to present findings

Working with Others

- Applying scientific experiments to reinforce the candidate's learning through group activities

This Unit has the Using Number component of Numeracy embedded in it. This means that when candidates achieve the Unit, their Core Skills profile will also be updated to show they have achieved Using Number at SCQF level 5.

Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website **www.sqa.org.uk/assessmentarrangements**

History of changes to Unit

Version	Description of change	Date
02	Core Skills Component Using Number at SCQF level 5 embedded.	28/11/2011