SQA Advanced Unit specification

General information

Unit title: Chemical Engineering: Principles (SCQF level 7)

Unit code: HV03 47

Superclass: YC

Publication date: November 2017

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to provide learners with the knowledge and understanding of the principles of mass and energy balances. This Unit is suitable for learners studying at SQA Advanced Certificate/Diploma level and will provide the necessary underpinning knowledge and skills to enable progression to further study of chemical engineering or to seek employment in chemical, oil and allied industries.

Outcomes

On successful completion of the Unit the learner will be able to:

1 Apply the principles of mass balances.
2 Apply the principles of energy balances.

Credit points and level

1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7)

Recommended entry to the Unit

Entry is at the discretion of the centre; however it is recommended that learners should have completed Mathematics at SCQF level 6 or equivalent.

Core Skills

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

Complete Core Skill	None
Core Skill component	Using Number at SCQF level 6

Context for delivery

This Unit is intended as part of the framework for SQA Advanced Diploma in Chemical Process Technology, SQA Advanced Diploma in Industrial Biotechnology and SQA Advanced Certificate in Chemical Engineering.

The Assessment Support Pack (ASP) for this Unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website **(http://www.sqa.org.uk/sqa/46233.2769.html)**.

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**.

SQA Advanced Unit specification: Statement of standards

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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.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Apply the principles of mass balances.

Knowledge and/or Skills

- Mass balance calculations and techniques
- Mass balance in an industrial context
- Data sources

Outcome 2

Apply the principles of energy balances.

Knowledge and/or Skills

- Energy balances techniques and data sources
- Energy balances in an industrial process
- Steam quality and consumption
- Single phase system
- Two phase systems

Evidence Requirements for this Unit

Written and/or oral recorded evidence for Outcome 1 may be assessed by a single closed-book assessment under supervised conditions. It is recommended that the assessment be completed within 45 minutes. Learners can only have access to non-programmable calculators when sitting the assessment.

Written and/or oral recorded evidence for Outcome 2 may be assessed by a single closed-book assessment under supervised conditions. It is recommended that the assessment be completed within 45 minutes. Learners can only have access to non-programmable calculators when sitting the assessment.

Alternatively, Outcomes 1 and 2 may be assessed using a holistic closed-book assessment under supervised conditions. It is recommended that the assessment be completed within 90 minutes. Learners can only have access to non-programmable calculators when sitting the assessment

Outcome 1

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

- use data sources to solve mass balance calculations (this may include mass fractions, volume fractions, mole fraction, dry and wet basis, or the inter-conversion of these terms).
- apply mass balance techniques and calculations to the tie component, individual component, multi-component systems.
- apply mass balance techniques and calculations in an industrial context such as mixing balances as applied to steady state processes, stoichiometry in simple processes or recycle operations.

Calculations must:

- apply appropriate formulae.
- apply the principles of the calculation.
- show workings through a calculation.
- provide reasonable answers to the questions asked. The answer should derive from the application of the formulae and correct application of the principles of the calculation.

Outcome 2

The assessment will sample four of the five Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed. Those items which are not sampled must be covered in the alternative (resit) assessment.

A learner's response will be judged satisfactory where the evidence shows that the learner can:

- apply data sources to energy balance techniques.
- apply energy balances to industrial processes.
- solve calculations on steam quality and consumption.
- apply energy balances to single phase systems.
- apply energy balances to two phase systems.

Calculations must:

- apply appropriate formulae.
- apply the principles of the calculation.
- show workings through a calculation.
- provide reasonable answers to the questions asked. The answer should derive from the application of the formulae and correct application of the principles of the calculation.

SQA Advanced 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 may form part of a group award or be completed as a free-standing Unit. It is designed to develop the necessary knowledge and skills in the principles and mass and energy balances, to process engineering systems.

In Outcome 1, learners are introduced to and then apply the principles of mass balances. Learners should therefore be able to calculate mass fractions, volume fractions, mole fraction, dry and wet basis analysis and the inter-conversion of these terms. The use of the tie component and individual component balances should then be introduced and learners should be able to apply these to steady state processes. Mixing streams, multiple Unit processes and recycling operations should then be introduced. Learners should be able to solve mass balances as reactive processes. In order to solve these problems, learners should use appropriate data tables. Learners should be able to solve mass balances based on industrial processes.

In Outcome 2, learners are introduced to and then apply the principles of energy balances. Learners should be able to apply the first law of thermodynamics, they should understand enthalpy and be able to prepare energy balances involving phase transitions. Learners should be able to calculate dryness fraction, flash steam and steam consumption. Learners should be able to solve energy balances based on industrial processes.

Guidance on approaches to delivery of this Unit

The Outcomes may be delivered in any order due to the stand-alone nature of the content of each Outcome.

It is envisaged that the delivery of Outcome 1 would commence with the delivery of data sources such as mass fractions, volume fractions, mole fraction, dry and wet basis analysis and the inter-conversion of these terms. Conversion of these terms can then be practiced throughout the remainder of the two Outcomes.

In Outcome 1, delivery may commence with the principles and application of mass balances to single and multiple component systems. Learners should be introduced to the tie component and individual component balances in steady state processes. Mass balances involving mixing streams may then be introduced, followed by application to multiple Unit processes. Mass balances involving recycling operations could then be introduced.

Within Outcome 1, learners should learn to solve mass balances as reactive processes. This may either be taught once learners understand the basic principles of multi-component mass balances, or may be taught on completion of the other elements within Outcome 1.

Learning in Outcome 2 may commence with an introduced to enthalpy and specific and molar heat capacity of materials. Learners may then learn to calculate enthalpy change over

a temperature range where heat capacities are variable and expressed as a polynomial of temperature.

Learners may then be introduced to the properties of steam, including ice, water, wet steam, dry saturated steam and superheated steam. Use of steam tables will be introduced, and used to calculate the dryness fractions of steam.

Learners' knowledge of the first law of thermodynamics should then be developed to perform simple energy balances to determine steam consumption. This may then be extended by calculations of throttling operations to improve the dryness fraction of steam and production of flash steam. Learners will learn to prepare energy balances involving phase transitions.

Once the fundamental concepts in Outcome 2 have been understood, learning should be consolidated by the use of calculations involving multiple skills within the Outcome. For example, learners could be asked to perform calculations to heat a material with a variable heat capacity, through a phase transition, using wet steam.

The Unit is designed to introduce candidates to the principles of mass and energy balances and their applications to industrial processes. Therefore delivery of both Outcomes should include examples of relevant industrial processes where possible. Such examples could include distillation Units, reactor systems, mixing systems, evaporators, crystallisers, separators, waste heat boilers, vaporisers or similar.

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.

Outcomes 1 and 2 could be assessed individually. Each Outcome could be assessed by a single closed-book assessment with an appropriate cut-off score. Assessment should be carried out in supervised conditions, and it is recommended that the assessment of each Outcome should last for 45 minutes. Learners can only have access to non-programmable calculators when sitting the assessment. Alternatively, a single holistic closed-book assessment may be used with an appropriate cut-off score.

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

Throughout this Unit candidates are required to perform calculations, manage formulae and equations that provide the opportunity to develop the Core Skill of *Numeracy* at SCQF level 6. In Outcome 2, candidates will also be required to interpret and plot graphs which again provide the opportunity to develop *Numeracy* at SCQF level 6.

The presentation of problems in assessments which candidates require to interpret and work through will also develop the Critical Thinking component of *Problem Solving* at SCQF level 6.

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 6.

History of changes to Unit

Version	Description of change	Date

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our Centre Feedback Form.

General information for learners

Unit title: Chemical Engineering: Principles (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 an SQA Advanced Certificate or as the first year of an SQA Advanced Diploma. It provides key skills to those entering the Chemical, Oil, Biotechnology, and allied sectors. Before progressing to this Unit, it would be beneficial to have completed either Higher Mathematics or equivalent SCQF level 6 qualifications where you will have learned underpinning skills of mathematical manipulation of formulae, integration and solving simultaneous equations.

On completion of this Unit you should be able to:

1 Apply the principles of mass balances.
2 Apply the principles of energy balances.

In Outcome 1, you will learn the concept of a mass balance and will then learn to perform mass balances. You will learn how to calculate mass fractions, volume fractions, mole fraction, dry and wet basis analysis and the inter-conversion of these terms. You will learn to perform overall as well as component mass balances and apply them to steady state process operations such as mixing streams, multiple unit processes and recycling operations.

In Outcome 2, you will apply the principles of energy balances based on the first law of thermodynamics. You will learn about enthalpy changes when heating or cooling process fluids. You will learn to calculate the dryness fraction of steam, flash steam and steam consumption. You will prepare energy balances for industrial processes.

You may be assessed by two separate closed-book assessments, one for each of the two Outcomes. Alternatively you may be assessed in a single assessment(s).

Although there is no automatic certification of Core Skills in the Unit, you will have opportunities to develop the Core Skills of *Numeracy* and *Problem Solving* at SCQF level 6.