SQA Advanced Unit specification

General information

Unit title: Chemical Engineering: Applied Physical Chemistry (SCQF level 7)

Unit code: HV01 47

Superclass: YC

Publication date: November 2017

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to enable learners to apply key aspects of physical chemistry. The 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 fundamental physical chemistry at SQA Advanced Diploma level or to seek employment in chemical based industries.

Outcomes

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

1 Apply the laws of thermodynamics to systems involving chemical and physical change.
2 Apply the principles of chemical kinetics to rates and mechanisms.
3 Apply the principles of gas-solid adsorption to heterogeneously catalysed reactions.

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 prior experience of Mathematics and Chemistry at SCQF level 6.

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

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**.

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.

Outcome 1

Apply the laws of thermodynamics to systems involving chemical and physical change.

Knowledge and/or Skills

- First Law of thermodynamics
- Thermodynamic functions
- Calculations using the appropriate thermodynamic equations
- Second Law of thermodynamics

Outcome 2

Apply the principles of chemical kinetics to rates and mechanisms.

Knowledge and/or Skills

- Kinetic data Calculations
- Batch reactors and Flow reactors
- Static and Flow techniques
- Homogenous and heterogeneous reactions
- Industrial applications of kinetics

Outcome 3

Apply the principles of gas-solid adsorption to heterogeneously catalysed reactions.

Knowledge and/or Skills

- Isotherms and factors affecting adsorption
- Gas-solid adsorption and related calculations
- Factors affecting heterogeneous catalysis

Evidence Requirements for this Unit

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills across all Outcomes.

Written and/or oral recorded evidence for Outcomes 1–3 should be assessed either using an holistic closed-book assessment under supervised conditions or assessing each Outcome separately. It is recommended that the assessment time in total should be no more than 90 minutes. Learners can only have access to the SQA Databook for Higher/Advanced Higher Chemistry or any suitable replacement when sitting the assessment.

The assessment will cover all of the Knowledge and/or Skills items.

Outcome 1

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

- apply the first law of thermodynamics.
- define thermodynamic functions, these should include enthalpy, entropy, internal energy, free energy.
- select and use the correct thermodynamic equation(s) to solve problems relating to Hess's Law, Kirchoff's Law and the equilibrium constant.
- apply the second law of thermodynamics.

Outcome 2

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:

- solve calculations using kinetic data. These calculations will include rate determining step, reaction rate and rate equation.
- explain how batch reactors and flow reactors work and the differences between batch and flow reactors.
- describe static and flow techniques for determining rates of reaction.
- describe homogenous and heterogeneous reactions, and the differences between them.
- apply chemical kinetics to industrial contexts, including using Maxwell Boltzmann distribution, activation energies and catalysis.

Outcome 3

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:

- describe Isotherms and factors affecting adsorption, at least three factors affecting adsorption should be given.
- apply the principles of gas-solid adsorption and perform an appropriate calculation using adsorption data.
- explain factors affecting heterogeneous catalysis, at least three factors affecting heterogeneous catalysis should be given.

SQA Advanced Unit Support Notes

Unit title: Chemical Engineering: Applied Physical Chemistry (SCQF level 7)

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 theoretical and applied aspects of physical chemistry and surface chemistry

Outcome 1

In this Outcome learners will study, first law of thermodynamic, state functions, relations between U, H,q,w and molar capacities, Hess's law, Kirchoff's law, reversible and irreversible systems. Entropy and the second law of thermodynamics. The applications of the equilibrium constant to industrial processes. The learners will be required to use appropriate equations to solve problems using data provided.

Outcome 2

In Outcome 2 learners will study homogeneous and heterogeneous reaction and the differences between them. They will learn about batch and flow reactors, including plug flow, and the differences between them. Learners will study reaction rate, rate equation, reaction order, rate determining step and collision theory. The use of static and flow methods to determine rates. This will lead into Maxwell Boltzmann distribution, activation energy and catalysis. Learners will learn study isothermal and adiabatic reactions. Learners will then look at applying what has been learnt to Industrial process, eg Haber Process.

Outcome 3

In this Outcome learners will study:

- Adsorption, adsorbant, adsorbate
- Chemical and physical adsorption
- Adsorption isotherms
- Langmuir isotherms
- Degree of cover
- Surface areas
- Heterogeneous catalysis
- Applications to industrial process.

Guidance on approaches to delivery of this Unit

There is no particular order in which it is envisaged that Outcomes are best delivered. Each Outcome stands on its own regarding content and therefore doesn't depend on a particular link from each Outcome.

It is envisaged that the content of this Unit could be delivered standalone, or embedded within other Units of the SQA Advanced award.

It is envisaged that delivery of Outcome 1 would commence with an introduction to thermodynamics, the definitions of the terms and the common symbols. The first law of thermodynamics would then be taught, the relationship between U, H, q, w and molar capacities. The learners would then develop their knowledge by using Hess's Law then progress into using Kirchoff's equation. The second law of thermodynamics would then be introduced, developing the learners understanding of entropy, calculations using entropy and phase changes. The next progression would be carrying out calculations using Gibbs free energy, the equilibrium constant and finally investigating the reaction isochore.

It is envisaged that delivery of Outcome 2 would commence with an introduction to kinetics, rate equations and reaction rates. This will lead into reaction speeds examining slow and fast reactions and how they would be measured. Progressing into types of reactors and the differences between batch and flow reactors. Learners would then learn about reactor kinetics and industrial applications.

It is envisaged that delivery of Outcome 3 would commence with an introduction to adsorption and the Langmuir isotherms. Then learners would be taught and practice adsorption calculations, factors affecting adsorption, gas-solid adsorption. Catalysis surface area, heterogeneous catalysis and industrial applications should then be delivered.

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.

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.

Outcomes 1, 2 and 3 could be assessed as three separate assessments due to the standalone nature of the topics or as a single holistic closed-book assessment with an appropriate cut-off score. Assessment should be carried out in supervised conditions, closed-book and could be a question and answers style assessment and it is recommended to last for 90 minutes. Learners should have access to the *SQA Databook for Higher/Advanced Higher Chemistry* or any suitable replacement when sitting the assessment.

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

There will be opportunities to develop Core Skills throughout this Unit, examples of which are as follows:

Numeracy — Using Number and Using Graphical Information at SCQF level 6

Learners will be required to decide on the steps and operations to solve complex problems, and carry out sustained and complex calculations throughout the Unit, along with using graphical data to solve problems, in particular in the kinetics Outcome.

Problem Solving — Critical Thinking at SCQF level 6

Learners will develop their critical thinking skills by solving problems, comparing processes and selecting formula.

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: Applied Physical Chemistry (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 may be studied as part of your first or second year of an SQA Advanced Certificate/Diploma or as a free-standing unit. Before progressing to this Unit it would be beneficial to have completed study in Chemistry and Mathematics at SCQF level 6 (Higher level) where you will have learned underpinning aspects of chemistry and developed your mathematical skills. There is a strong emphasis in the Unit on the applications of the physical chemistry taught and in particular industrial applications.

On completion of the Unit you should be able to:

1 Apply the laws of thermodynamics to systems involving chemical and physical change.
2 Apply the principles of chemical kinetics to rates and mechanisms.
3 Apply the principles of gas-solid adsorption to heterogeneously catalysed reactions.

Outcomes 1

In Outcome 1 you will learn about the first law of thermodynamics, the relationship between common terms. You will learn about Hess's law and Kirchoff's equation, then use these to solve problems. The problems you are given will have an industrial application so that you can relate the theory to how it can be applied to solve problems.

Outcome 2

In Outcome 2 you will learn about reaction kinetics, how to determine reaction kinetics. You will be taught about batch and flow reactors, their differences and when each type is appropriate to use. You will learn about activation energies, catalysis and industrial applications.

Outcome 3

This Outcome covers surface chemistry, it introduces the subject of adsorption, and related calculations. The Langmuir isotherm is discussed and applied. Catalysis, in particular heterogeneous catalysis is investigated, surface area is calculated and gas-solid adsorption is discussed.

Assessment

For Outcomes 1 to 3 you will take a closed-book, end of Unit assessment. This may be as a single assessment or three shorter individual assessments.

Core Skills

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.