SQA Advanced Unit Specification

General information for centres

Unit title: Fundamental Concepts of Physical Chemistry

Unit code: HV98 47

Unit purpose: This Unit is designed as part of the SQA Advanced Certificate/Diploma in Applied Sciences and Chemistry and will provide candidates with the underpinning knowledge, problem solving skills and practical techniques associated with key concepts of physical chemistry.

On completion of the Unit the candidate should be able to:

1 Describe and use the principles, law and formulae associated with gas behaviour, chemical kinetics, chemical thermodynamics and phase equilibria.
2 Perform laboratory techniques related to physical chemistry.

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

**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 National 1 to Doctorates.*

Recommended prior knowledge and skills: Entry is at the discretion of the centre, however it is recommended that candidates should have completed the SQA Advanced Unit Fundamental Chemistry: Theory and Practice (HV4H 47) or equivalent, or have recent experience of Chemistry at Higher level.

Core skills: There may be opportunities to gather evidence towards core skills in Numeracy, Communication and Problem Solving at SCQF level 6 in this Unit, although there is no automatic certification of core skills or core skills components.

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. This Unit is included within the SQA Advanced Diploma in Applied Sciences and SQA Advanced Diploma in Chemistry frameworks but may also be offered as part of other SQA Advanced programmes.

Assessment: Outcome 1 will be assessed using a closed-book end of Unit assessment. The questions should reflect a representative sample from the content detailed in the support notes. Outcome 2 will be assessed by means of a report and a checklist based on practical activities related to the topics in Outcomes 1 and 2.

Unit specification: statement of standards

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The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

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. Candidates 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

Describe and use the principles, laws and formulae associated with gas behaviour, chemical kinetics, chemical thermodynamics and phase equilibria

Knowledge and/or skills

- gas laws and models of gas behaviour
- chemical kinetics
- thermodynamics in chemical reactions
- phase equilibria of one and two component systems

Evidence requirements

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- describe gas behaviour and perform calculations involving gas laws
- predict, explain and interpret factors affecting reaction rates and apply to given systems
- apply and explain concept of first and second laws in terms of calculations involving thermodynamic quantities
- perform calculations involving Hess's law
- describe behaviour of one component systems in terms of phase diagrams
- apply Raoults law to two component systems

Evidence should be gathered using a holistic closed-book assessment under supervised conditions.

The questions set in the assessment should cover knowledge and skills although a representative sample of the topics covered in the support notes should be covered. It is envisaged the assessment will entail a mixture of short answer and structured questions. The allocation of marks per question should be weighted on the basis of the level of response and the amount of effort required.

It is envisaged that candidates will have access to the SQA Databook for Higher/Advanced Higher Chemistry or another suitable replacement when sitting the assessment.

Assessment guidelines

It is suggested that that assessment should be worth a total of 50 marks, which should be weighted 10 marks for gas laws and behaviour, 10 for kinetics, 20 for thermodynamics and 10 for phase equilibria. The pass mark for the overall assessment should be 60%. Should candidates fail to gain 60% they should be offered a second attempt after suitable remediation.

Outcome 2

Perform laboratory techniques related to physical chemistry

Knowledge and/or skills

- follow instructions to perform a range of chemical experiments
- work in a safe manner regarding current health and safety regulations
- achieve consistent and accurate results
- report the results clearly and concisely
- data analysis and interpretation
- identify sources of experimental errors and estimate size of errors as appropriate

Evidence requirements

Evidence for this Outcome will be provided by the candidates:

- performing practical activities in line with instructions and health and safety regulations
- achieving acceptably accurate results from practical activities
- analysing and interpreting experimental data
- submitting a full and complete laboratory report

A checklist will be used to record the results of the candidate's practical work on at least two occasions. Candidates must also complete a laboratory diary or proforma. For one of the experiments carried out the candidate must also produce a laboratory report which demonstrates the candidate's ability to plan and evaluate the laboratory exercise.

Laboratory reports should be clear and concise, with correctly stated aims, full experimental method details, all raw data and correctly presented and interpreted calculations. Any graphs required should be presented in the appropriate format in terms of scaling, units, best fit, title etc.

A report/worksheet which is unacceptable should be redrafted with appropriate remediation. If the redrafted report is unacceptable, re-assessment will take the form of a new report on a different experiment.

Assessment guidelines

The evidence for development of practical skills could be gathered on an ongoing basis by lecturer observation evidenced by a checklist and need not be restricted to the assessment experiments. It is expected that a series of practical exercises will be undertaken, with the aim of developing appropriate skills before assessment is attempted. Written/oral assessment should be obtained from two significant practical exercises, one of which will be assessed using checklists and one by means of a report. More than two exercises suitable for assessment by these routes are likely to be undertaken, so that additional practical reassessments will be unnecessary.

This could take the form of an individual assignment with limited guidance, or of a more complex project undertaken by small groups of candidates. A separate report/worksheet should be completed by each candidate, which in the case of a group project should be supplemented by checklist evidence to establish the candidate's design input and practical contribution.

Administrative information

Unit code: HV98 47

Unit title: Fundamental Concepts of Physical Chemistry

Superclass category: RD

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced Qualifications.

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

Unit specification: support notes

Unit title: Fundamental Concepts of Physical Chemistry

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 40 hours.

Guidance on the content and context for this Unit

This Unit is intended as part of the framework for SQA Advanced Certificate/SQA Advanced Diploma in Applied Sciences and SQA Advanced Diploma Chemistry courses buy may be suitable for inclusion in other SQA Advanced Certificate/SQA Advanced Diploma Science awards. It is designed to further develop the theoretical and practical aspects of physical chemistry introduction in Fundamental Chemistry: Theory and Practice. The aim is to give candidates the underpinning theoretical, data analysis and practical chemical skills to facilitate them to function as effective technicians or to progress to more advanced study.

Outcome 1

Qualitative description of gas behaviour using kinetic model. Temperature related to kinetic energy. Boltzman distributions. Gas laws: Charles, Boyle, Guy-Lussac, Dalton, Ideal. Calculations involving gas laws. Origin of non-ideal behaviour. Diffusion and effusion and calculations thereon.

Qualitative description of factors affecting reaction rate; effect of reactant concentration/pressure; activation energy; effect of temperature; catalysts (activation theory). Reaction order (1^{st} and 2^{nd}) and examples of mechanisms and concept of rate determining step (eg Sn1, Sn2).

Laws of thermodynamics. Forms of energy: heat, internal energy, enthalpy, work. Hess's law and calculations. Concept of entropy, introduction of Gibbs free energy, calculations and spontaneity. Heat capacity and temperature change.

Phase Equilibria: phase diagrams; effect of pressure on freezing/boiling points; Raoults law; partition coefficients.

Outcome 2

Candidates will encounter a range of practical activities which support the theory from Outcome 1. Suitable practical activities might include:

- kinetics of iodine/propanone reaction
- effects of factors on rates of clock reactions
- investigation of gas laws
- determination of partition coefficient
- experimental determination with Hess's law
- calorimetric determination

Guidance on the delivery and assessment of this Unit

This Unit is likely to form part of a group award, which is designed both to prepare candidates for employment in science related posts and to offer the possibility of articulation into more advanced study. The emphasis therefore should be on ensuring candidates comprehend the basic fundamentals of physical chemistry and are able to correctly analyse and interpret experimental data.

Independent study should be encouraged by using candidate-centred, resource based methodologies. It is envisaged that ICT based approaches will feature in the delivery of the Unit.

The assessment of Outcome 1 is by a holistic test worth 50 marks, which should be weighted 10 marks for gas laws and behaviour, 10 for kinetics, 20 for thermodynamics and 10 for phase equilibria. The allocation of marks per question should be weighted on the basis of the level of response and the amount of effort required. The pass mark for the overall assessment will be 60%.

In Outcome 2, candidates will be assessed on their ability to perform laboratory work to a required standard, to correctly analyse and interpret data, and to present their findings in a suitable and sufficient laboratory report. It is envisaged that the analysis of experimental data will necessitate graphical and/or mathematical data manipulation of a standard appropriate to SQA Advanced study at level 7.

Laboratory reports should be clear and concise, with correctly stated aims, full experimental method detail, all raw data and correctly presented and interpreted calculations. Any graphs required should be presented in the appropriate format in terms of scaling, units, best fit, title etc.

A laboratory diary or proforma will be kept and learners should be introduced to Standard Operating Procedures (SOPs). Laboratory reports should be in an appropriate format. Health and Safety, in regard to risk and COSHH assessments should be emphasised at all times.

Should a candidate fail to carry out an experiment to the required standard, a further attempt at an alternative experiment should be offered. Where a laboratory report does not meet the required standard a candidate should be given the opportunity to resubmit following remediation. While only two practicals are required for assessment purposes, it is envisaged that candidates will participate in several experiments during the course of the Unit.

Open learning

If this Unit is delivered by open or distance learning methods, additional planning resources may be required for candidate support, assessment and quality assurance.

A combination of new and traditional authentication tools may have to be devised for assessment and re-assessment purposes.

For further information and guidance, please see *Assessment and Quality Assurance of Open and Distance Learning* (SQA, February 2001, publication code A1030).

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.

General information for candidates

Unit title: Fundamentals of Physical Chemistry

This is a 1 credit SCQF level 7 Unit, intended to be delivered as part of an SQA Advanced Certificate/SQA Advanced Diploma science qualification. It is designed to give you the basic skills and knowledge in the essential aspects of physical chemistry.

On completion of this Unit you should be able to:

1 Describe and apply the basic chemical principles associated with gas behaviour, chemical kinetics, chemical thermodynamics and phase equilibria.
2 Perform laboratory techniques related to physical chemistry.

The main components of the Unit are described in more detail below:

Outcome 1

Description of gas behaviour using kinetic model. Calculations involving use of gas laws: Charles, Boyle, Guy-Lussac, Dalton, Ideal gas law. Origin of non-ideal behaviour. Diffusion and effusion of gases.

Description of factors affecting reaction rate; effect of reactant concentration/pressure; activation energy; effect of temperature; catalysts. Concept of reaction mechanisms.

Laws of thermodynamics (1^{st}, 2^{nd} and 3^{rd}). Forms of energy: heat, internal energy, enthalpy, work. Hess's law and calculations. Concept of entropy, Gibbs free energy, calculations and spontaneity. Heat capacity and temperature change.

Phase Equilibria: phase diagrams; effect of pressure on freezing/boiling points; Raoults law; partition coefficients.

Outcome 1 will be assessed by a single, end of unit, closed-book test covering a selection of topics from each of the four sections above, with 60% overall mark required for a pass.

Outcome 2

In this Outcome you will carry out a range of practical activities which will support the theory from Outcome 1. Although it is likely that a range of practicals will be covered, only two will be formally assessed. For assessment purposes you will be required to perform laboratory work to a set standard, to correctly analyse and interpret data, and to present your findings for one activity in a suitable and sufficient laboratory report.