## SQA Advanced Unit Specification

## General information for centres

## Unit title: Fundamental Concepts of Organic Chemistry

## Unit code: HV97 47

**Unit purpose:** This Unit is designed as part of the SQA Advanced Certificate/Diploma awards in Applied Sciences and Chemistry. Candidates will develop a knowledge of the mechanism of organic chemical reactions. Experiments will be completed based on an understanding of these reaction mechanisms.

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

1 Predict the outcome of organic chemical reactions involving aliphatic molecules.
2 Describe common organic reaction mechanisms.
3 Perform experiments to illustrate a range of organic chemical reactions.

**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 Communication, Problem Solving and Numeracy 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:** Outcomes 1 and 2 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 3 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

## Unit title: Fundamental Concepts of Organic Chemistry

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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

Predict the outcome of organic chemical reactions involving aliphatic molecules

### Knowledge and/or skills

- substitution
- addition
- elimination
- oxidation
- reduction
- free radical
- substrates
- functional groups
- reagents
- condition
- products
- stereochemical terms
- geometric and optical isomers

## Outcome 2

Describe common organic reaction mechanisms

### Knowledge and/or skills

- substitution
- addition
- elimination
- free radical

### Evidence requirements for Outcomes 1 and 2

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can pass an end of Unit assessment, carried out under closed-book conditions. The questions set in the assessment should cover all knowledge and skills of Outcome 1, and a minimum of two of knowledge and skills from Outcome 2. The paper should also include at least two questions which require the candidates to explain the stereochemical implications of the mechanism.

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.

### Assessment guidelines for Outcomes 1 and 2

The assessment should be holistic and either based on all, or a representative selection of the reactions reflecting the range of chemical transformations covered in this Unit. At least two different types of reaction mechanism should be assessed. The pass mark for the assessment should be 60%. Should candidates fail to gain 60% they should be offered a second attempt after sufficient remediation.

## Outcome 3

Perform experiments for a range of organics chemical reaction types

### 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
- identify sources of experimental errors and estimate size of errors as appropriate

### Evidence requirements

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 candidates ability to plan and evaluate the laboratory exercise and to note and comment on any pertinent mechanistic or stereochemical issues.

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.

The experiments chosen should be consistent with the synthetic, mechanistic and stereochemical knowledge and skills requirements of Outcomes 1 and 2. Experiments should be chosen which either explore which mechanism may be operating during an organic chemical reaction, illustrates the mechanistic course of a reaction, or the stereochemical implications of the mechanism operating. Some form of product analysis should also be involved. This may mean that the practical exercise used here could be integrated with another Unit. For example analysis of the product(s) may involve some chromatographic of spectroscopic technique, allowing integration with the instrumental techniques units.

A report/worksheet which is unacceptable should be redrafted with appropriate remediation. If the redrafted report is unacceptable, reassessment 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 evidence 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.

Where melting points or boiling points are used to identify a product these should be within 5C of the literature value.

# Administrative information

**Unit code:** HV97 47

**Unit title:** Fundamental Concepts of Organic Chemistry

**Superclass category:** RD

**Date of publication:** November 2017

**Version:** 01

**History of Changes:**

| Version | Description of change | Date |
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**Source:** SQA



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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 Organic 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 in Chemistry courses but may be suitable for inclusion in other SQA Advanced Science awards. It is designed to further develop the theoretical and practical aspects of organic chemistry introduced in Fundamental Chemistry: Theory and Practice. The aim is to give learners a knowledge of the preparation of simple aliphatic compounds, the basic mechanisms of organic chemical reactions and the stereochemical implications and effect of the mechanism operating. Candidates will also carry out experiments illustrating the mechanistic course of a chemical reaction and the way in which the mechanism may determine the stereochemistry of the product(s).

**Outcomes 1 and 2**

Candidates should be able to predict the mechanism and products of simple chemical reactions. They should gain a knowledge of the methods used to prepare different classes of aliphatic compounds and be able to suggest suitable mechanistic pathways.

- nucleophilic substitution reactions (SNI and SN2) using common nucleophiles
- addition reactions to carbon — carbon double bonds using, for example, halogen, hydrogen halides (Markovnikov's rule) and others
- addition to carbon — oxygen double bonds using, common reactants (such as bisulphite, hydrogen cyanide, oximes, Grignard reagents and others)
- elimination reactions used to prepare alkenes (E1 and E2)
- free radical reactions as in the halogenation of methane and in additions to carbon — carbon double bonds (anti-Markovnikov)

Candidates will also be expected to predict the products of such reactions and to give suitable reagents and conditions. They should also be able to suggest suitable general mechanisms for representative reactions.

Where appropriate learners should be introduced to the use of curved arrows to show electron movement.

Where different mechanistic pathways lead to different stereochemical outcomes, either through optical isomerism or geometric isomerism, the candidates should be able to predict the stereochemical and suggest reagents and conditions that may favour one mechanistic path over another. To ensure candidate can achieve this it will be necessary to cover stereochemical topics and terminology such as conformation, geometric isomerism (cis/trans, E/Z), optical isomerism, chirality, enantiomers, optical activity, racemic mixtures and racemisation, retention/inversion of configuration and resolution of an enantiomeric mixture.

**Outcome 3**

Candidates should perform a range of experiments (but only two of these should be used for assessment purposes and a laboratory report should be completed for one experiment).

Assessors are free to choose any experiments that will allow the candidate to demonstrate the knowledge and/or skills and evidence requirements of this Outcome.

For example, an experiment or range of experiments could be chosen which illustrate or explore the mechanistic pathway of a particular reaction using a specific set of conditions and reagents and this could be compared and contrasted with the outcome of using another set of conditions and/or reagents. Classical or instrumental methods could be used to analyse the product or product mixture.

In their reports, candidates should be able to offer an explanation of the implied mechanistic and/or stereochemical outcomes of the experiment.

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.

## Guidance on the delivery and assessment of this Unit

This Unit is likely to form part of a Group Award, which is primarily designed to prepare candidates for employment in a science related area. The emphasis should be on encouraging the learner to think about the practical implications on the product obtained and product stereochemistry of the mechanism under study.

Independent study should be encourage by using candidate centered, resource based methodologies.

The assessment of Outcome 1 and 2 is by a single holistic assessment and could be worth 50 marks and carried out under closed-book conditions. The marks given could be split as shown:

- 12-14 marks or organic chemical mechanisms
- 10-12 marks for the accurate use and application of stereochemical terms
- 10-12 marks for the prediction of products
- 12-14 marks for substrates, functional groups, reagents and conditions

This information is for guidance purposes only and is in an attempt to ensure that the assessment reflects the work of the Unit.

Candidates should achieve 60% of the possible marks to pass the assessment.

The assessment of Outcome 3 consists of three elements. This is to ensure that all the knowledge and skills required for this Outcome are assessed. A checklist should be used to record the candidate's competence at carrying out the actual experiment. A laboratory diary or proforma should be kept by the candidate and inspected by the assessor to ensure the accurate recording of results. The candidate must also produce one laboratory report which demonstrates the candidates ability to plan and evaluate the laboratory exercise and to note or comment on any pertinent mechanistic or stereochemical issues.

## Open learning

If this Unit is delivered by open or distance learning methods, additional planning and resources may be required for candidate support, assessment and quantity assurance. A combination of new and traditional authentication tools may have to be devised for assessment and reassessment purposes. In particular candidates will need detailed advice as to fulfilling the requirements of Outcome 2.

For further information and advice, 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: Fundamental Concepts of Organic Chemistry

This is a 1 credit SQCF level 7 Unit, intended to be delivered as part of an SQA Advanced Certificate/SQA Advanced Diploma science qualification. It is likely to be delivered in the first year of an SQA Advanced Diploma programme. It is designed to give you knowledge of the mechanisms used to explain simple reactions in organic chemistry and to introduce you to the ideas an concepts of stereochemistry. Since many different mechanisms have different implications for the stereochemistry found in the products of chemical reactions it makes sense to study both together.

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

1 Predict the outcome of organic chemical reactions involving aliphatic molecules.
2 Describe common organic reaction mechanisms.
3 Perform experiments to illustrate a range of organic chemical reactions.

In Outcomes 1 and 2 you will learn about the theoretical issues and implications of reaction mechanisms and stereochemistry. On completion of this Outcome you should be able to illustrate:

- nucleophilic substitution reactions (SNI and SN2) using common mucleophiles
- addition reactions to carbon — carbon double bonds using, for example, halogen, hydrogen halides (Markovnikov's rule) and others
- addition to carbon — oxygen double bonds using, common reactants (such as bisulphite, hydrogen cyanide, oximes, Grignard reagents and others)
- elimination reactions used to prepare alkenes (E1 and E2)
- free radical reactions as in the halogenation of methane and in addition to carbon — carbon double bonds (anti-Markovnikov)
- the use of oxidation and reduction reactions (no mechanism required)

You will be expected to predict the products of such reactions and to give suitable reagents and conditions. You will also be able to give general mechanisms for representative reactions from the above.

You will be shown how to use curved arrows to show electron movement.

Where different mechanistic pathways lead to different stereochemical outcomes, either through optical isomerism or geometric isomerism, you will be shown how to predict the stereochemical outcome and suggest reagents and conditions that may favour one mechanistic path over another. To ensure that you can achieve this it will be necessary for you to cover stereochemical topics and terminology such as conformation, geometric isomerism (cis/trans, E/Z), optical isomerism, chirality, enantiomers, optical activity, racemic mixtures and racemisation, retention/inversion of configuration, resolution of an enantiomeric mixture.

In Outcome 3 you will carry out a range of experiments and you will need to produce one report, which demonstrates your ability to plan and evaluate the laboratory exercises. You will also need to note or comment on any pertinent mechanistic or stereochemical issues.

You will be given instructions for each experiment and will learn to:

- follow these instructions and perform a range of experiments which illustrate or explore the mechanism of an organic chemical reactions
- work in a safe manner regarding current health and safety regulations
- achieve consistent and accurate results
- report the results of your experiments clearly and concisely
- note and explain any mechanistic or stereochemical inferences drawn

You will be shown how to keep a laboratory diary or proforma and be introduced to SOPs. You will be shown how to produce laboratory reports in an appropriate format. Health and Safety, in regard to risk and COSHH assessments will be emphasised at all times and you will be required to take responsibility and due care of your own Health and Safety and the Health and Safety of those around you.