

SQA Advanced Unit Specification

General information for centres

Unit title: Base-Catalysed Reactions and Organometallic Reagents in Organic Synthesis

Unit code: HV9D 48

Unit purpose: This Unit is a specialised Unit designed as part of the SQA Advanced Diploma awards in Chemistry and Applied Sciences. Candidates will develop a knowledge of organic chemical synthesis involving both base-catalysed reactions and organometallic reagents. Reactions will be carried out to illustrate the synthesis of target molecules.

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

- 1 Devise synthetic routes to target molecules using base-catalysed reagents.
- 2 Devise synthetic routes to target molecules using organometallic reagents.
- 3 Apply standard methods of synthesis to prepare target molecules.

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

**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: Access to this Unit is at the discretion of the centre, but it is preferable for candidates to be able to demonstrate a knowledge of Organic Chemistry at SCQF level 7. Where the Unit is delivered as part of an SQA Advanced Science Group Award, it is anticipated that candidates will have completed level 7 Units in Fundamental Chemistry: Theory and Practice (HV4H 47) and Fundamental Concepts of Organic Chemistry (HV97 47) prior to commencing this Unit.

Core skills: There may be opportunities to gather evidence towards the Core skills of Communication 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.

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Assessment: Outcomes 1 and 2 will be assessed using a single holistic, end of Outcome, assessment carried out under closed-book conditions.

Outcome 3 will be assessed by observing the candidate perform laboratory exercises, the inspection of the candidate's laboratory diary and the completion by the candidate of one laboratory report.

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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

Devise synthetic routes to target molecules using base-catalysed reagents

Knowledge and/or skills

- ◆ carbanions
- ◆ mechanisms
- ◆ synthetic routes
- ◆ products

Outcome 2

Devise synthetic routes to target molecules using organometallic reagents

Knowledge and/or skills

- ◆ reagents
- ◆ synthetic routes
- ◆ products

Evidence requirements

Candidates will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can pass a single end of Unit assessment covering Outcomes 1 and 2, carried out under closed book conditions.

Assessment should include questions involving multi stage synthesis. At least three different types of organometallic reactions and three different types of base-catalysed reactions should be selected for assessment purposes.

Assessment guidelines

The assessment covering Outcomes 1 and 2 should be holistic and based on a representative selection of the reagents used to carry out these syntheses. The pass mark for the test will be 60%. Should candidates fail to gain 60% marks they should be offered a second attempt after sufficient remediation.

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Outcome 3

Use standard methods of synthesis to prepare target molecules

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

Assessment guidelines

The experiments chosen should be consistent with the knowledge and skills requirements of Outcome 1 and 2. Experiments may be chosen which illustrate both the use of organometallic reagents and base-catalysed synthetic strategies. 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 or spectroscopic technique, allowing integration with the instrumental techniques Units. Assessors are free to determine the total number of experiments that are carried out based on the length of time taken for each exercise and the time available. It may be that some experiments will be two or three stage processes and this should be taken into consideration when devising the assessment programme.

It is not necessary that one of the assessed experiments involves an organometallic reagent and the other is base-catalysed. Rather, the assessed experiments chosen should reflect the time, equipment and facilities available.

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Administrative information

Unit code:	HV9D 48
Unit title:	Base-Catalysed Reactions and Organometallic Reagents in Organic Synthesis
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Unit specification: support notes

Unit title: Base-Catalysed Reactions and Organometallic Reagents in Organic Synthesis

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 to be part of the SQA Advanced Diploma in Chemistry and Applied Sciences. It may also be suitable for inclusion in other science SQA Advanced Certificate/SQA Advanced Diploma awards. The aim is to give learners a knowledge of the use of organometallic reagents and base-catalysed reactions in the synthesis of target molecules in synthetic organic chemistry. Learners will also carry out experiments illustrating the use of such methods.

Outcomes 1 and 2

Candidates will be expected to be able to predict the product(s) of reactions involving standard synthetic methods using organometallic reagents and base-catalysed reactions.

They will use their knowledge of the use of a representative range of organometallic reagents to devise synthetic routes to target molecules. Tutors are free to decide on which organometallic reagents are used to illustrate their synthetic utility but it is envisaged that emphasis will be given to the more common 'textbook' examples.

They will also use their knowledge of base-catalysed reactions (for example: aldol, ethyl acetoacetate, diethyl malonate, Claisen condensation etc.) to devise a synthetic route to target molecules.

Learners should also be able to discuss and illustrate the formation of carbanions and the factors affecting their stability.

Outcome 3

Due to the flammable, and poisonous nature of organometallic reagents tutors are asked to take special care when selecting suitable and appropriate synthetic routes to illustrate their use.

A checklist, the details of which should be pertinent to the practical and manipulative aspects of the experiment should be drawn up. The checklist should include issues regarding the safe and accurate following of the instructions. The checklist will be used to assess the practical element of the candidate's work.

Candidates should perform a range of experiments, but only two of these should be used for assessment purposes. For one of the two assessed practical exercises, the candidate must produce a report which demonstrates the candidate's ability to plan and evaluate the laboratory exercise and to note or comment on any pertinent observations.

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A laboratory diary or proforma should 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 encouraged by using candidate-centred, 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

15–20 marks for synthesis involving organometallic reagents

20–25 marks for synthesis involving base-catalysed reactions

5–10 mark on the formation and stability of carbanions

This is in an attempt to ensure that the assessment reflects the work of the Unit.

For Outcome 3, Assessors are free to determine the total number of experiments that are carried out based on the length of time taken for each exercise and the time available. It may be that some experiments will be two or three stage processes and this should be taken into consideration when devising the assessment programme.

A report should be produced for one experiment. It is not necessary that one of the assessed experiments involves an organometallic reagent and that the other is base-catalysed. Rather, the assessed experiments chosen should reflect the time, equipment and facilities available.

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 3.

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.

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General information for candidates

Unit title: Base-Catalysed Reactions and Organometallic Reagents in Organic Synthesis

This is a 1 credit SQCF level 8 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 a knowledge of the use of organometallic reagents and base-catalysed reactions in the synthesis of target molecules.

You will also carry out a number of organic syntheses which are included for two reasons.

- 1 To illustrate and demonstrate in a practical manner the use of organometallic and base-catalysed methods.
- 2 To increase your ability to carry out practical chemical experiments.

In Outcome 1 and 2 you will learn to devise synthetic strategies to target molecules using these methods. Specifically you will learn how to:

- ◆ predict the product(s) of reactions involving standard synthetic methods
- ◆ use a representative range of organometallic reagents (magnesium, lithium, zinc etc) to devise a synthetic route to target molecules
- ◆ form carbanions and draw conclusions about their stability
- ◆ use base-catalysed reactions (aldol, ethyl acetoacetate, diethyl malonate, claisen condensation) to devise a synthetic route to target molecules

You will also be expected to predict the products of such reactions and to give suitable reagents and conditions.

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

You will be given instructions for each experiment and you need to be able to demonstrate that you can:

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

You will be shown how to keep a laboratory diary and be introduced to Standard Operating Procedures (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.

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Assessment

The assessment of Outcome 1 and 2 is by an end of Unit assessment that will be carried out under closed book assessment.

The assessment of Outcome 3 consists of two experiments, a laboratory diary and the report of one of the experiments that you have carried out. A checklist will be used to record your performance of the practical exercise itself.