SQA Advanced Unit specification

General information for centres

Unit title: Base-Catalysed and Organometallic Chemistry: Theory and Laboratory Skills (SCQF level 8)

Unit code: HV0X 48

Superclass: RD

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Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to enable learners to understand key aspects of base-catalysed and organometallic chemistry, and it will develop knowledge of synthetic routes to a wide range of base-catalysed and organometallic compounds. The Unit is suitable for learners studying at SQA Advanced Diploma level, and will provide the necessary underpinning knowledge and skills to enable progression to further study of base-catalysed and organometallic chemistry at degree level or to seek employment in science based industries.

Outcomes

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

1 Devise synthetic routes to target molecules using base-catalysed reactions.
2 Devise synthetic routes to target molecules using organometallic reagents.
3 Perform practical experiments related to base-catalysed and organometallic synthesis.

Credit points and level

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

Recommended entry to the Unit

Entry is at the discretion of the centre, however it is recommended that learners should have completed the Unit HV0L 47 *Organic Chemistry: Theory and Laboratory Skills* or equivalent.

Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the Support Notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

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.

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

Devise synthetic routes to target molecules using base-catalysed reactions.

Knowledge and/or Skills

- Reaction mechanisms in base-catalysed chemistry
- Target products

Outcome 2

Devise synthetic routes to target molecules using organometallic reagents.

Knowledge and/or Skills

- Reaction mechanisms using organometallic reagents
- Target product synthesis

Outcome 3

Perform practical experiments related to base-catalysed and organometallic synthesis.

Knowledge and/or Skills

- Base-catalysed and organometallic synthesis experiments
- Working safely, within current health and safety regulations
- Consistent and accurate results
- Recording observations and results
- Evaluation skills
- Result analysis and conclusions

Evidence Requirements for this Unit

Written and/or oral recorded evidence for Outcomes 1 and 2 should be assessed using a holistic closed-book assessment under supervised conditions. It is recommended that the assessment be completed within 90 minutes.

Written and/or oral recorded evidence for Outcome 3 should be assessed by production of a full laboratory report, or by completion of an appropriate pro forma. An assessor's observation checklist could be used to record performance evidence of practical experiments.

Outcome 1

The assessment will cover all of Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed.

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

- Explain reaction mechanisms in base-catalysed reactions.
- Devise synthetic routes to target molecules.

Outcome 2

The assessment will cover all of Knowledge and/or Skills items. Learners will not have prior knowledge of which items are being assessed.

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

- Explain reaction mechanisms using organometallic reagents.
- Devise synthetic routes to target molecules.

Outcome 3

Learners will perform a minimum of two practical experiments, the content of which will be related to Outcomes 1−2. A learner's response will be judged satisfactory where the evidence shows that the learner can achieve all of the following:

- Follow instructions to perform experiments related to base-catalysed and organometallic synthesis.
- Work in a safe manner regarding current health and safety regulations.
- Achieve consistent and accurate results.
- Record experimental observations and results clearly and accurately.
- Evaluate validity of results in terms of sources of and values of experimental errors.
- Analyse results correctly and state valid conclusions.

An assessor observation checklist will be used to record the learner's performance of the practical work in line with given instructions and health and safety requirements.

Learners must report one of the two practical experiments by production of a full laboratory report. Learners may report the remaining practical experiment by production of a full laboratory report or by completion of an appropriate pro forma. Where a pro forma approach

is deployed, the pro forma will not present information or assistance to the learners on how to correctly perform calculations, analyse experimental results or experimental errors. Learners will be expected to perform such activities independently on the basis of the experimental data.

Where a learner does not perform an assessed experiment to the required standard, they will be given the chance to either re-attempt the same practical activity, or to undertake a different practical experiment of similar complexity. Where a laboratory report or pro forma does not meet required standard, then the learner will be given a single opportunity to re-draft. If the required standard is still not attained, then an alternative practical experiment will be set.

SQA Advanced Unit Support Notes

Unit title: Base-Catalysed and Organometallic Chemistry: Theory and Laboratory Skills (SCQF level 8)

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 is part of the framework for the SQA Advanced Diploma in Applied Sciences and the SQA Advanced Diploma in Applied Chemical Sciences but may be suitable for inclusion in other SQA Advanced Science and Engineering awards. It is designed to develop the theoretical and practical aspects of organic chemistry introduced in the Unit HV0L 47 *Organic Chemistry: Theory and Laboratory Skills*, and also to introduce learners to theories of base-catalysed and organometallic synthesis.

Outcome 1 and 2

Learners will be expected to be able to predict the products of reactions involving standard synthetic methods using base-catalysed reactions and organometallic reagents. They will use their knowledge of the use of a range of organometallic reagents to devise synthetic routes to target molecules. Learners could also use this knowledge to retrosynthetically develop a synthetic route from a product back to starting materials. A range of organometallic reagents should be taught to learners to develop a breadth of knowledge however it is envisaged that the main emphasis will be on the common 'textbook' examples.

Learners will use their knowledge of base-catalysed reactions (for example: aldol, synthesis of ketones using ethyl 3-oxobutanoate (ethyl acetoacetate), Dieckmann reaction, Michael reaction, synthesis of carboxylic acids using propandioic acid (diethylmalonate), Claisen reaction etc) to devise synthetic routes to target molecules.

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

Curly arrows should be used to show the correct mechanism of reaction.

Outcome 3 — Perform practical experiments related to base-catalysed and organometallic synthesis

Guidance on suitable practical experiments for assessment purposes is given elsewhere in this document. However, it is envisaged that learners will also participate in a range of other practical experiments which will both develop their laboratory skills and support the theory covered in Outcomes 1 and 2.

In carrying out such activities, learners should follow Good Laboratory Practice (GLP) and carry out or be familiar with the risk and Control of Substances Hazardous to Health (COSHH) assessments on all procedures undertaken.

Opportunities should be taken to develop awareness of the sources of experimental error and of the accuracy of measurements, with quantification of errors where possible.

Guidance on approaches to delivery of this Unit

This Unit will require a mixture of delivery methods. The main theory is likely to be delivered in taught classes however there is the potential for project and group work to research topics. Tutorial classes may be useful to support of theory classes and project/group work.

It is envisaged that Outcome 3 will be delivered alongside the theoretical based Outcomes 1 and 2. A range of practical experiments could be utilised to both support understanding of the underlying theory and to prepare learners for undertaking the assessed practical experiments. Aspects suitable for experimental investigation might include synthesis of suitable base-catalysed and/or organometallic reactions.

Care should be taken to ensure that experiments are suitable in terms of compounds used. It is the responsibility of the delivering centre to ensure that compounds are handled safely (eg in a fume cupboard) and that no particularly toxic compounds are used (eg carcinogens, compounds that may affect fertility, pregnancy). Delivering centres should check and risk assess every compound to be used.

Potential experiments may involve multi stage experiments and therefore may take more than one laboratory session to complete.

It is expected that learners analyse their products using IR and/or boiling/melting point to determine that they have correctly synthesised the required product. Literature melting /boiling points should be referenced by the learners.

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 by a single holistic closed-book assessment with an appropriate cut-off score. Assessment should be carried out in supervised conditions, and it is recommended that the assessment be completed within 90 minutes.

In Outcome 3 learners are required to undertake two assessed practical experiments, the content of which will be related to Outcomes 1−2. Examples of suitable experiments are given below. However, this list is not prescriptive, and other practical experiments of similar complexity may be used by the centre.

Suitable practical experiments for Outcome 3 are:

- Devise synthetic routes to a wide range of compounds, using base-catalysed reactions and organometallic reagents.
- Use a wide range of synthetic techniques to produce a range of organic compounds.

Assessed practical experiments will usually be performed individually. However, there may be some experiments that are suitable to be undertaken in pairs or small groups. If this is the case then the assessor should ensure that all participants are actively involved and are able to adequately demonstrate the required skills.

An exemplar instrument of assessment with marking guidelines has been produced to indicate the national standard of achievement at SCQF level 8.

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

The delivery and assessment of this Unit will provide learners with the opportunity to develop the Core Skills of *Problem Solving* at SCQF level 6, and *Information and Communication Technology (ICT)* at SCQF level 4.

Problem Solving — Reviewing and Evaluating at SCQF level 6

Following assessed practical experiments learners will be required to review and evaluate the effectiveness of the exercise with a thorough interpretation of random and systematic sources of error. They will be required to reach sound conclusions on the basis of the data collected and the inherent errors.

Information and Communication Technology (ICT) — Providing/Creating Information at SCQF level 4

Learners will make effective and appropriate use of ICT packages to produce laboratory reports in an appropriate format. Packages used will likely include word processing, spreadsheets, and specialist chemical structure software.

Sustainability

Sustainability can be embedded in delivery of the Unit in a variety of ways. For example, by encouraging minimum usage, correct disposal procedures and possibly recycling (eg of solvents) during practical experiments.

History of changes to Unit

Version	Description of change	Date

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.

General information for learners

Unit title: Base-Catalysed and Organometallic Chemistry: Theory and Laboratory Skills (SCQF level 8)

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 8, which you are likely to be studying as part of the second year of an SQA Advanced Diploma science programme. Before progressing to this Unit it would be beneficial to have completed the Unit HV0L 47 *Organic Chemistry: Theory and Laboratory Skills*, where you will have learned underpinning aspects of organic chemistry and developed your practical skills. This Unit will enable you to understand key aspects of base-catalysed and organometallic chemistry, and you will develop knowledge of synthetic routes to a wide range of base-catalysed and organometallic compounds.

On completion of this Unit you should be able to:

1 Devise synthetic routes to target molecules using base-catalysed reactions.
2 Devise synthetic routes to target molecules using organometallic reagents.
3 Perform practical experiments related to base-catalysed and organometallic synthesis.

Outcome 1

In this Outcome you will cover base-catalysed reactions, and you will learn how to predict products by devising synthetic strategies to a target molecule. You will also learn about carbanions, and their stability.

Outcome 2

In this Outcome you will cover organometallic reagents, and you will learn how to predict products by devising synthetic strategies to a target molecule.

Outcome 3

In this Outcome you will undertake practical experiments, based on the content of Outcomes 1 and 2.

During this work, you will also be expected to develop good laboratory practices as well as improve your skills of manipulation, observation and measurement. You will also be encouraged to develop safe working practices and to strive constantly to improve the accuracy and reliability of your results. The reporting and analysis of experimental data is an important aspect of the practical sessions.

Assessment

For Outcomes 1 and 2 you will take a closed-book, end of Unit assessment.

Outcome 3 will be assessed after you have learned the necessary practical skills, and will take the form of two practical experiments, for which you will report your results either in full lab reports, or by completion of pro forma reports.

Core Skills

Although there is no automatic certification of Core Skills in the Unit, you will have opportunities to develop the Core Skills of *Problem Solving* at SCQF level 6 and *Information and Communication Technology (ICT)* at SCQF level 4.