Higher National Unit specification

General information

Unit title: Organic Stereochemistry: Theory and Laboratory Skills (SCQF level 8)

Unit code: H934 35

Superclass: RD

Publication date: November 2018

Source: Scottish Qualifications Authority

Version: 02

Unit purpose

This Unit is designed to enable learners to understand key aspects of organic stereochemistry. Learners will also develop practical skills in techniques relevant to organic stereochemistry. The Unit is suitable for learners studying at HND level, and will provide the necessary underpinning knowledge and skills to enable progression to further study of organic stereochemistry 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 Explain and apply the principles of stability, conformational analysis and stereochemistry to alicyclic hydrocarbons and describe the reactions of these compounds.
2 Analyse the configuration of compounds with more than one chiral centre and describe reactions, including those which generate a second chiral centre.
3 Perform practical experiments related to organic stereochemistry.

Credit points and level

1 Higher National Unit 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 HN Unit H933 34 *Organic Chemistry: Theory and Laboratory Skills* or equivalent.

Higher National Unit Specification: General information (cont)

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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**.

Higher National 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

Explain and apply the principles of stability, conformational analysis and stereochemistry to alicyclic hydrocarbons and describe the reactions of these compounds.

Knowledge and/or Skills

- Valence bond theory
- Conformational analysis
- Chemical reactions

Outcome 2

Analyse the configuration of compounds with more than one chiral centre and describe reactions, including those which generate a second chiral centre.

Knowledge and/or Skills

- Two centre configuration
- Chemical reactions

Outcome 3

Perform practical experiments related to organic stereochemistry.

Knowledge and/or Skills

- Organic stereochemistry experiments
- Working safely, within current health and safety regulations
- Consistent and accurate results
- Recording observations and results
- Evaluation skills
- Result analysis and conclusions

Higher National Unit specification: Statement of standards (cont)

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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 one hour. Learners can only have access to the *SQA Databook for HN Chemistry* or any suitable replacement when sitting the assessment.

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

Outcome 1

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:

- Explain the stability and reaction of a range of cycloalkanes/cycloalkenes using valence bond theory.
- Apply conformational analysis to a range of cyclic compounds.
- Describe the chemical reactions of a range of cyclic compounds.

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:

- Analyse compounds with more than one chiral centre and assign their configuration.
- Describe chemical reactions relating to organic stereochemistry, including those that lead to the formation of compounds with two chiral centres.

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 organic stereochemistry.
- 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.

Higher National Unit specification: Statement of standards (cont)

Unit title: Organic Stereochemistry: Theory and Laboratory Skills (SCQF level 8)

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, completion of an appropriate pro forma or a laboratory diary entry. 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 laboratory diary approach is deployed, the laboratory diary must meet all of the requirements of a pro forma (in particular an evaluation of experimental errors), as set out in the Understanding Standards materials.

Where a learner does not perform an assessed practical experiment to the required standard, they will be given the chance to either reattempt the same practical experiment, or to undertake a different practical experiment of similar complexity. Where a laboratory report, pro forma or laboratory diary does not meet the 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.

Higher National Unit Support Notes

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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 intended as part of the framework for HNC/HND Applied Sciences and HND Applied Chemical Sciences but may be suitable for inclusion in other HN Science and Engineering awards. It is designed to develop the theoretical and practical aspects of organic stereochemistry introduced in the HN Unit H933 34 *Organic Chemistry: Theory and Laboratory Skills*, and also to introduce learners to more stereochemistry of organic compounds.

Outcome 1 — Explain and apply the principles of stability, conformational analysis and stereochemistry to alicyclic hydrocarbons and describe the reactions of these compounds

Learners will be expected to explain the stability and reaction of cycloalkanes using valence bond theory, this would probably include the stability and reactions of cyclopropane, cyclobutane, cycloepentane and cyclohexane.

Conformational analysis of cyclohexane and other suitable compounds should be studied to include chair, boat and twist boat confirmation. In addition, the variation in energy of the confirmations of these compounds should be covered. Derivatives of cyclohexane should also be covered for conformation and stereochemistry.

Cycloalkanes and cycloalkenes should be studied including the reactions of these compounds and related stereochemistry.

Outcome 2 — Analyse the configuration of compounds with more than one chiral centre and describe reactions, including those which generate a second chiral centre

Learners should be able to determine the configuration of organic compounds with more than one chiral centre and assign their configuration.

Learners should be able to describe the streochemical consequences of reactions, including being able to show how a two chiral centre molecule can be generated.

Higher National Unit Support Notes (cont)

Unit title: Organic Stereochemistry: Theory and Laboratory Skills (SCQF level 8)

Outcome 3 — Perform practical experiments related to organic stereochemistry

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

There is no particular order in which Outcomes 1 and 2 would be best delivered. It is envisaged that laboratory work and demonstrations will feature across the delivery of each of the Outcomes, and that the assessed practical experiments for Outcome 3 will be undertaken in similar timeframe to the underpinning theory.

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 supplement the theory and project work.

It is envisaged that delivery of Outcome 1 could commence with coverage of valence bond theory in order to allow learners to understand the stability and reactions of several cycloalkanes and cycloalkenes. Cycloalkanes to be covered could include cyclopropane, cyclobutane, cyclopentane and cyclohexane.

Learners should examine chair, boat and twist conformation of cyclohexane, and delivery should cover the variation in energy of the conformations of cyclohexane. Learners should also study derivatives of cyclohexane and they should examine their conformation and stereochemistry.

Cycloalkanes and cycloalkenes should be covered to include their reactions and the related stereochemistry for these compounds.

The use of appropriate models may be useful when delivering stability and conformational analysis to allow learners to visualise structures.

Delivery of Outcome 2 could commence with learners comparing cis and trans configurations, and examining R & S conformers. Enantiomers and meso distereomers should also be covered to give learners a breadth of knowledge in stereochemistry.

In addition to understanding the organic stereochemistry of this Unit, learners should be familiar on how to represent these compounds using a variety of projections for drawing chiral compounds. These projections should include Fisher, Sawhorse and Newman.

Higher National Unit Support Notes (cont)

Unit title: Organic Stereochemistry: Theory and Laboratory Skills (SCQF level 8)

Learners should be taught how to describe the reactions of a range of cyclic compounds, and learners should also be able to explain the stereoisomers formed and how reactions can be predicted to form specific stereochemical products. Compounds with chiral centres should be covered and learners should be given the opportunity to develop their skills in describing the reactions that will lead to compounds with two chiral centres. Learners should also be taught how to describe the expected product from given reactions.

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. Care should be taken to ensure that experiments are suitable in terms of compounds used and they must not involve compounds deemed to have a suspected or known health and safety risk to learners.

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

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 60 minutes. Learners can only have access to the *SQA Databook for HN Chemistry* or any suitable replacement when sitting the assessment.

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 activities could include:

- Bromination of trans Stilbene
- Mutarotation of glucose
- Inversion of glucose
- Resolution of racemic phenethylamine using tartaric acid
- Analysis of tartaric acid in wine by polarimetry
- Reaction of cyclopentadiene with maleic anhydride

Suitable practical experiments for this Unit will be varied and diverse, and they will depend on the facilities available within the centre. Organic chemistry experiments will use potentially toxic and hazardous reagents, and appropriate equipment must be used and risk assessments carried out. The practical experiments selected must be appropriate to the facilities available.

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.

Higher National Unit Support Notes (cont)

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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
2	One of the experiments must be reported by production of a full laboratory report. The remaining experiment can be reported by production of a full laboratory report, completion of an appropriate pro forma or a laboratory diary entry.	Nov 2018

General information for learners

Unit title: Organic Stereochemistry: 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 HND Science programme. Before progressing to this Unit it would be beneficial to have completed the HN Unit H933 34 *Organic Chemistry: Theory and Laboratory Skills*, where you will have learned underpinning aspects of organic chemistry and developed your practical skills. There will be a strong emphasis on the importance of experimental data in understanding chemical principles, and on the applications of chemical knowledge in practical situations.

On completion of this Unit you should be able to:

1 Explain and apply the principles of stability, conformational analysis and stereochemistry to alicyclic hydrocarbons and describe the reactions of these compounds.
2 Analyse the configuration of compounds with more than one chiral centre and describe reactions, including those which generate a second chiral centre.
3 Perform practical experiments related to organic stereochemistry.

Outcome 1

In this Outcome you will cover the concept of conformation, stability and stereochemistry of cyclic organic compounds. This will include the study of a variety of cycloalkanes and cycloalkenes. You will also study how these compounds react and the stereochemistry of the products.

Outcome 2

In this Outcome you will study compounds with more than one chiral centre, including how to assign the configuration of each centre. You will also study reactions relating to organic stereochemistry, including those that lead to the formation of a second chiral centre.

Outcome 3

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

During this practical 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.

General information for learners (cont)

Unit title: Organic Stereochemistry: Theory and Laboratory Skills (SCQF level 8)

Assessment

For Outcomes 1 and 2 you could 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 a full laboratory report, a pro forma report or a laboratory diary entry. You must produce a full laboratory report for at least one practical experiment.

Core Skills

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