



Higher National Unit specification

General information

Unit title: Chemistry: Laboratory Practical Skills (SCQF level 8)

Unit code: H92R 35

Superclass: RD

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Unit purpose

This Unit is designed to equip learners with advanced laboratory skills to ensure that they are competent in completing complex laboratory tasks to a high degree of accuracy. This Unit is particularly appropriate for learners undertaking either HND Applied Sciences or HND Applied Chemical Sciences. It is intended that the Unit will equip such learners with advanced skills of, and knowledge in, advanced laboratory work so as to facilitate potential progression to Year 3 BSc or employment.

Outcomes

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

- 1 Perform analytical and synthetic procedures.
- 2 Perform methods of purification.
- 3 Perform methods for determination of purity.
- 4 Use the advanced settings of an analytical instrument to optimise analytical performance.

Credit points and level

1 Higher National Unit credit at SCQF level 8: (8 SCQF credit points at SCQF level 8)

Higher National Unit Specification: General information (cont)

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Recommended entry to the Unit

Learners should have qualifications in chemistry at SCQF level 7, covering both underpinning theory and laboratory skills. The Units H92X 34 *Fundamental Chemistry: Theory and Laboratory Skills*; H933 34 *Organic Chemistry: Theory and Laboratory Skills*; H936 34 *Physical Chemistry: Theory and Laboratory Skills* and H939 35 *Transition Metal Chemistry: Theory and Laboratory Skills* would constitute appropriate prior knowledge.

It is also expected that learners would have skills in the operation of analytical instruments, with either of the Units H930 35 *Instrumental Techniques 1* or H937 35 *Spectroscopic and Analytical Techniques*. Effective communication skills would also be required.

Core Skills

Achievement of this Unit gives automatic certification of the following:

Complete Core Skills	None
Core Skill components	Critical Thinking at SCQF level 6 Using Graphical Information at SCQF level 6

There are also opportunities to develop aspects of Core Skills which are highlighted in the Support Notes of this Unit Specification.

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

Perform analytical and synthetic procedures.

Knowledge and/or Skills

- ◆ Multistage synthesis of an organic product
- ◆ Analytical measurements related to physical chemistry
- ◆ Synthesis and analysis of an inorganic product
- ◆ Multistage analytical procedures

Outcome 2

Perform methods of purification.

Knowledge and/or Skills

- ◆ Recrystallisation
- ◆ Sublimation
- ◆ Fractional distillation
- ◆ Column chromatography
- ◆ Solvent extraction

Outcome 3

Perform methods for determination of purity.

Knowledge and/or Skills

- ◆ Melting point
- ◆ Thin Layer Chromatography (TLC)
- ◆ Instrumental chromatography
- ◆ Spectroscopy

Higher National Unit specification: Statement of standards (cont)

Unit title: Chemistry: Laboratory Practical Skills (SCQF level 8)

Outcome 4

Use the advanced settings of an analytical instrument to optimise analytical performance.

Knowledge and/or Skills

- ◆ Prepare analytical instruments to perform measurements
- ◆ Alter the analytical method to optimise results

Evidence Requirements for this Unit

Outcome 1

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ Complete a minimum of four practical exercises covering at least three of the Knowledge and Skills items.
- ◆ Correctly analyse and interpret the data and draw conclusions.
- ◆ Identify and evaluate experimental errors.
- ◆ Record the results in an appropriate format, to produce full laboratory reports on a minimum of three occasions.

Outcome 2

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can complete three of the methods below to produce materials of a high purity. The purity of the resultant material should be determined by a suitable method.

- ◆ Recrystallisation
- ◆ Sublimation
- ◆ Fractional distillation
- ◆ Column chromatography
- ◆ Solvent extraction

The learners should record the results in an appropriate format. If these practicals are performed as 'stand-alone' activities (see Assessment Guidelines) the learners should record the results in pro forma reports, whereas if assessed along with Outcome 1 the results would be subsumed within the reports for that Outcome.

A checklist will be used to record the learner's performance in the laboratory.

Higher National Unit specification: Statement of standards (cont)

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Outcome 3

Learners must provide evidence to demonstrate their Knowledge and/or Skills by showing that they can complete three of the methods below to assess the purity of a substance.

- ◆ Melting point
- ◆ Thin Layer Chromatography (TLC)
- ◆ Instrumental chromatography
- ◆ Spectroscopy

The learners should correctly interpret and explain the results of the given practical method, in terms of the purity of the given compound.

The learners should record the results in an appropriate format. If these practicals are performed as 'stand-alone' activities (see Assessment Guidelines) the learners should record the results in pro forma reports, whereas if assessed along with Outcome 1 the results would be subsumed within the reports for that Outcome.

A checklist will be used to record the learner's performance in the laboratory.

Outcome 4

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills by showing that they can:

- ◆ Set up and calibrate the given analytical instrument.
- ◆ Perform subsequent measurements.
- ◆ Critically analyse the instrument performance.
- ◆ Vary a minimum of two conditions to optimise results.

The assessment should be construed such that the initial operating conditions are given to the learner and that these will produce non-optimum results. The learner should identify the conditions which are to be altered, and should systematically do so until optimum results are achieved.

The learners should record and interpret the results in an appropriate format, which will include mathematical analysis of the optimisation.

A checklist will be used to record the learner's performance in the laboratory.



Higher National Unit Support Notes

Unit title: Chemistry: Laboratory Practical 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 intended to be part of the HND Applied Sciences and HND Applied Chemical Sciences Group Awards. The aim is to build on the practical skills which are developed in the other Units of these awards to equip learners with the advanced practical skills to facilitate employment, for example, as laboratory technicians. The nature of this Unit should allow integration with other Units from the Group Award, with practical exercises being linked from some of the more theoretical Units in the course.

Outcome 1

Learners will complete a set of four practical activities which will be both complex in nature and require the use of a broad range of equipment and techniques. These activities will cover at least three of the four areas of organic, physical, analytical and inorganic chemistry. Examples of appropriate practicals are as follows:

- ♦ **Organic Chemistry** — learners could synthesise an organic product, in a synthesis which would require at least two steps. The intermediate product may be isolated or used in situ, and the final product would be isolated and analysed. It is expected that this synthesis will link to the theory from the organic chemistry Units of the course. There are many suitable syntheses which could be used, with relevant examples including organometallic synthesis and diazotisation products.
- ♦ **Physical Chemistry** — an experiment performing analytical measurements which links to aspects of theory from the physical chemistry Units of the course. Examples might include determination of rate law (eg SN1 or SN2) or construction of a phase diagram for a ternary liquid mixture.
- ♦ **Inorganic Chemistry** — a transition metal complex could be synthesised and analysed by appropriate methods to elucidate or analyse the properties and/or formulae of the complex.
- ♦ **Analytical Chemistry** — learners could complete the multistage analysis of a suitable material, eg a consumer product or environmental sample. A suitable example would be a foodstuff, which might be analysed for salt, fat, protein and moisture content.

Higher National Unit Support Notes (cont)

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Outcomes 2 and 3

In Outcome 2, learners will perform methods of purification, with a minimum of three from recrystallisation, sublimation, fractional distillation, column chromatography and solvent extraction. It is envisaged that these methods of purification could be performed as part of the practical exercises in Outcome 1, although they could also be performed as 'stand-alone' practical activities. The learners will be required to determine the purity of the final products, and it is envisaged that this could form the basis of the assessment for Outcome 3 where learners will be required to perform three methods from melting point determination, TLC, instrumental chromatography and spectroscopy.

Outcome 4

It is expected that learners will already have experience of operating a range of analytical instruments, for example through either of the Units H937 35 *Spectroscopic and Analytical Techniques* or H930 35 *Instrumental Techniques 1*. In this Unit they will be building on those skills, utilising the more advanced features of the instrument to achieve optimum results. Wherever possible, learners should set the instruments from the beginning, switching them on, calibrating them, programming in the method and obtaining the required results. It is required that learners identify and systematically alter instrument or experimental parameters and monitor the effect on the analysis.

Guidance on approaches to delivery of this Unit

This Unit is likely to form part of a Group Award designed to provide learners with laboratory knowledge and skills for employment at science technician level.

It is envisaged that the Unit would be delivered subsequent to Units covering underpinning chemistry theory and practical skills. In particular, it is expected that learners will have achieved a high level of competency in volumetric and gravimetric analysis, organic synthetic methods and spectroscopic and chromatographic analysis.

Guidance on approaches to assessment of this Unit

In Outcome 1 learners will complete four assessed practicals as specified. A combination of observation checklist and a laboratory report should be used to assess the work. Outcomes 2 and 3 are designed such that the assessments could be combined into holistic assessments with Outcome 1, although they could equally well be run as 'stand-alone' exercises.

For Outcome 4 it is expected that the learners will identify for themselves the parameters which are to be altered, and will systematically do so to achieve optimum results.

Laboratory reports should be clear and concise, with all results and calculations reported. Learners should discuss the results in terms of their accuracy and reliability, taking into account inherent experimental errors.

Should a learner fail to carry out experiments to the required standard, further attempts can be offered.

Higher National Unit Support Notes (cont)

Unit title: Chemistry: Laboratory Practical Skills (SCQF level 8)

Outcome 1

It would be expected that the assessed practicals would each involve 3–6 hours of laboratory time, and will require the learners to utilise a broad range of techniques to ensure that a suitable skill set is assessed.

The organic synthesis should involve at least two steps. There are many suitable syntheses which could be used, with relevant examples including organometallic synthesis and diazotisation products.

Examples of suitable physical chemistry practicals might include determination of rate law (eg SN1 or SN2) or construction of a phase diagram for a ternary liquid mixture.

A suitable analytical practical could involve the multistage analysis of a material, eg a consumer product or environmental sample. An appropriate example would be a foodstuff, which might be analysed for salt, fat, protein and moisture content.

Laboratory reports should also be produced to assess the learner's ability to record, analyse and discuss laboratory work, to draw conclusions and to evaluate sources of error.

Outcome 2

It is envisaged that these methods of purification could be performed as part of the practical exercises in Outcome 1, although they could also be performed as 'stand-alone' practical activities.

The determinations of the purity of the resultant materials could form the basis of some or all of the assessment for Outcome 3.

Outcome 3

It is envisaged that these methods of determination of purity could be performed as part of the practical exercises in Outcome 1, and could be used to determine the purity of the materials from Outcome 2, although they could also be performed as 'stand-alone' practical activities or combined with Outcome 2 only.

Outcome 4

There are a range of analytical techniques which could be suitable for this assessment. These could include, for example, High Performance Liquid Chromatography (HPLC), Gas Chromatography (GC) and Atomic Absorption Spectroscopy (AAS).

Higher National Unit Support Notes (cont)

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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

This Unit has the Problem Solving component of Critical Thinking and Using Graphical Information of Numeracy embedded in it. This means that when candidates achieve the Unit, their Core Skills profile will also be updated to show they have achieved Critical Thinking and Using Graphical Information at SCQF level 6.

The delivery and assessment of this Unit will provide learners with the opportunity to develop the Core Skills of *Numeracy* and *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 practicals 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 — 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. It is also to be expected that certain of the analytical instruments used will be operated via computer, and that databases may be deployed.

History of changes to Unit

Version	Description of change	Date

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General information for learners

Unit title: Chemistry: Laboratory Practical 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 Unit covers a range of advanced laboratory skills. The aim is to build on the skills which are developed in the other Units of HND Applied Sciences or HND Applied Chemical Sciences to equip you with the advanced practical skills to facilitate employment, for example, as a laboratory technician.

Outcome 1

You will complete a set of four practical activities which will be both complex in nature and require the use of a broad range of equipment and techniques. These activities will cover at least three of the four areas of organic, physical, analytical and inorganic chemistry.

Outcomes 2 and 3

In Outcome 2, you will perform methods of purification, with a minimum of three from recrystallisation, sublimation, fractional distillation, column chromatography and solvent extraction. It is envisaged that these methods of purification could be performed as part of the practical exercises in Outcome 1, although they could also be performed as 'stand-alone' practical activities. You will be required to determine the purity of the final products, and it is envisaged that this could form the basis of the assessment for Outcome 3 where you will be required to perform three methods from melting point determination, Thin Layer Chromatography (TLC), instrumental chromatography and spectroscopy.

Outcome 4

It is expected that you will already have experience of operating a range of analytical instruments, for example through either of the Units H937 35 *Spectroscopic and Analytical Techniques* or H930 35 *Instrumental Techniques 1*. In this Unit you will be building on those skills, utilising the more advanced features of the instrument to achieve optimum results.

The Unit will be assessed by the performance of practical activities and by the completion of laboratory reports including correct interpretation and analysis of results.

Core Skills

There will be extensive opportunities to develop Core Skills throughout this Unit, examples of which are as follows:

Numeracy (Using Graphical Information at SCQF level 6)- You will be required to extract, analyse, and interpret graphical and spectral information, and collate the information. Also, you will be required to select appropriate forms of complex tables, charts, diagrams to communicate complex information in these forms for the purposes of laboratory reports.

Problem Solving (Reviewing and Evaluating at SCQF level 6)- Following assessed practicals you will be required to review and evaluate the effectiveness of the exercise with a thorough interpretation of random and systematic sources of error. You will be required to reach sound conclusions on the basis of the data collected and the inherent errors.

General information for learners (cont)

Unit title: Chemistry: Laboratory Practical Skills (SCQF level 8)

Information and Communication Technology (Providing/Creating Information at SCQF level 4)- You 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. It is also to be expected that certain of the analytical instruments used will be operated via computer, and that databases may be deployed.