



## Higher National Unit specification: general information

**Unit title:** Chemistry: Laboratory Practical Skills

**Unit code:** H0PM 35

**Superclass:** RD

**Publication date:** February 2012

**Source:** Scottish Qualifications Authority

**Version:** 01

### Unit purpose

This Unit is designed to equip candidates with advanced laboratory skills to ensure that they are competent in completing complex laboratory tasks to a high degree of accuracy. On completion of the Unit candidates should be able to:

- ◆ Perform analytical and synthetic procedures
- ◆ Perform methods of purification
- ◆ Perform methods for determination of purity
- ◆ Use the advanced settings of an analytical instrument to optimise analytical performance

This Unit is particularly appropriate for candidates undertaking either the HND Applied Science or the HND Applied Chemistry. It is intended that the Unit will equip such candidates with advanced skills of, and knowledge in, advanced laboratory work so as to facilitate potential progression to year 3 BSc or employment.

### Recommended prior knowledge and skills

Candidates should have qualifications in chemistry at SCQF level 7, covering both underpinning theory and laboratory skills. The Units DH2K 34 *Fundamental Chemistry: Theory and Practice*; DP2P 34 *Fundamental Concepts of Organic Chemistry*; DP2R 34 *Fundamental Concepts of Physical Chemistry*; and DROE 35 *Transition Metal Chemistry* would constitute appropriate prior knowledge.

It is also expected that candidates would have skills in the operation of analytical instruments, with either of the Units DH54 35 *Instrumental Techniques: Theory and Practice 1* or FV6W 35 *Spectroscopic and Analytical Techniques: Theory and Practice*. Effective communication skills would also be required, which could for example be evidenced by the Unit DG70 34 *Presentation Skills in Science*.

## General information (cont)

### Credit points and level

1 Higher National Unit 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 Access 1 to Doctorates.*

### Core Skills

There are opportunities to develop the following Core Skills in this Unit, although there is no automatic certification of Core Skills or Core Skills components:

- ◆ *Numeracy* at SCQF level 6
- ◆ *Information and Communication Technology (ICT)* at SCQF level 4
- ◆ *Problem Solving* at SCQF level 6

### 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.

## Higher National Unit specification: statement of standards

**Unit title:** Chemistry: Laboratory Practical Skills

**Unit code:** H0PM 35

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

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.

#### Evidence Requirements

Candidates 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 be full lab reports on a minimum of three occasions

### Outcome 2

Perform methods of purification.

#### Knowledge and/or Skills

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

## Higher National Unit specification: statement of standards (cont)

**Unit title:** Chemistry: Laboratory Practical Skills

### Evidence Requirements

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

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

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

### Outcome 3

Perform methods for determination of purity.

### Knowledge and/or Skills

- ◆ Melting Point.
- ◆ Thin Layer Chromatography (TLC).
- ◆ Instrumental Chromatography.
- ◆ Spectroscopy.

### Evidence Requirements

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

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

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

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

## Higher National Unit specification: statement of standards (cont)

**Unit title:** Chemistry: Laboratory Practical Skills

### 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

Candidates 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 candidate and that these will produce non-optimum results. The candidate should identify the conditions which are to be altered, and should systematically do so until optimum results are achieved.

The candidates 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 candidate's performance in the laboratory.

## Higher National Unit specification: support notes

### Unit title: Chemistry: Laboratory Practical Skills

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 HNC/HND Applied Science and HND Applied Chemistry frameworks. The aim is to build on the practical skills which are developed in the other Units of these awards to equip students 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

Candidates 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** — candidates 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** — candidates 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 specification: support notes (cont)

**Unit title:** Chemistry: Laboratory Practical Skills

### Outcomes 2 and 3

In Outcome 2, candidates 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 candidates 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 candidates will be required to perform three methods from melting point determination, TLC, instrumental chromatography and spectroscopy.

### Outcome 4

It is expected that candidates will already have experience of operating a range of analytical instruments, for example through either of the Units FV6W 35 *Spectroscopic and Analytical Techniques: Theory and Practice* or DH54 35: *Instrumental Techniques Theory and Practice 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, students 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 students identify and systematically alter instrument or experimental parameters and monitor the effect on the analysis.

## Guidance on the delivery of this Unit

This Unit is likely to form part of a Group Award designed to provide candidates 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 candidates will have achieved a high level of competency in volumetric and gravimetric analysis, organic synthetic methods and spectroscopic and chromatographic analysis.

## Higher National Unit specification: support notes (cont)

**Unit title:** Chemistry: Laboratory Practical Skills

### Guidance on the assessment of this Unit

In Outcome 1 candidates will complete four assessed practicals as specified. A combination of observation checklist and a written 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 candidates 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. Candidates should discuss the results in terms of their accuracy and reliability, taking into account inherent experimental errors.

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

### Assessment Guidelines

#### Outcome 1

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

The organic synthesis should involve at least 2 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 candidate'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.

## Higher National Unit specification: support notes (cont)

**Unit title:** Chemistry: Laboratory Practical Skills

### 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).

## Online and Distance Learning

Although this Unit could be delivered by distance learning, it would require a considerable degree of planning by the centre to ensure the sufficiency and authenticity of candidate evidence. Arrangements would have to be made to ensure that:

- ◆ the practical activities are supervised by a responsible person and clearly recorded (using an assessment checklist, or on video) for the assessor
- ◆ and that the assessor is, at some point, able to question the candidate on that performance (face-to-face, by telephone, online)

For information on open learning arrangements, please refer to the SQA guide *Assessment and Quality Assurance of Open and Distance Learning* ([www.sqa.org.uk](http://www.sqa.org.uk))

## Higher National Unit specification: support notes (cont)

**Unit title:** Chemistry: Laboratory Practical Skills

### Opportunities for developing Core Skills

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

*Numeracy* (using graphical information SCQF Level 6). Candidates will be required to extract, analyse, and interpret graphical and spectral information, and collate the information. Also, candidates 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 SCQF Level 6). Following assessed practicals candidates 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* (proving/creating information SCQF Level 4). Candidates 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.

### Disabled candidates and/or those with additional support needs

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website [www.sqa.org.uk/assessmentarrangements](http://www.sqa.org.uk/assessmentarrangements)

## History of changes to Unit

Version	Description of change	Date

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## General information for candidates

### Unit title: Chemistry: Laboratory Practical Skills

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 the HND Applied Science or HND Applied Chemistry to equip you with the advanced practical skills to facilitate employment, for example, as laboratory technicians.

#### 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, 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 FV6W 35 *Spectroscopic and Analytical Techniques: Theory and Practice* or DH54 35: *Instrumental Techniques Theory and Practice 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 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 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 candidates (cont)

**Unit title:** Chemistry: Laboratory Practical Skills

*Information and Communication Technology* (proving/creating information 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.