

Higher National Unit Specification

General information for centres

Unit title: Instrumental Techniques: Theory and Practice 2

Unit code: DH2N 35

Unit purpose: This unit is designed to introduce candidates to a range of options available in instrument design and control, which can be used to optimise analytical results.

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

1. Describe the main factors within an instrument, which can be altered to optimise the analytical results.
2. Perform experiments using a range of advanced analytical techniques.
3. Develop methods to obtain optimum results from a range of analytical instruments.

Credit value: 1 HN 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.*

Recommended prior knowledge and skills: Access to this unit will be at the discretion of the centre however it would be an advantage if the student had prior experience of working in a science laboratory. In particular it would be beneficial to have completed the HN Unit Instrumental Techniques 1 or an equivalent unit.

Core skills: There may be opportunities to gather evidence towards core skills of problem solving, numeracy and communications at higher level in this unit, although there is no automatic certification of core skills or core skills components.

Context for delivery: This unit is included in the framework of the group award, HND Biotechnology although it is suitable for all HN science awards. It is recommended that it should be taught and assessed within the subject area of the particular group award to which it contributes.

Assessment: Outcome 1 will be assessed using a case study where the student is asked to compare different forms of instrument design or set up in terms of the expected analytical results. Outcomes 2 and 3 will be assessed using a number of practical exercises, two of which will be used for assessment purposes. The practical exercises should be more complex in nature, allowing the student to programme the instrument to allow comparison of different conditions and how they effect the analytical results. It is recommended that the practical exercises take the form of mini projects running over 2 or 3 laboratory sessions.

Higher National 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.

Outcome 1

Describe the main factors within an instrument, which can be altered to optimise the analytical results

Knowledge and/or skills

- ◆ Main components which can be changed to suit different analyses
- ◆ Range of options available to alter the reaction conditions during an analysis
- ◆ Implications of changing the reaction conditions and linking this to the likely experimental result

Evidence requirements

The candidate should discuss two modern analytical instruments, outlining all the aspects of instrument and experimental design. In particular identifying which components are common to all instruments and those where the analyst may have a choice depending on the work to be carried out. The case studies ideally should also encourage the candidate to detail the various aspects of experimental design, which can be changed by the analyst to improve results.

Assessment guidelines

The assessment of this outcome is by completion of a case study/assignment. Candidates will be encouraged to access various sources of information before submitting their answers. Two analytical instruments should be discussed in some detail, with candidates concentrating on the key components, which can be chosen or set by the analyst to obtain optimum results. The report should be approximately 2000 words in length and a pass would require candidates to demonstrate that they understand the operation of the instruments they discuss. They should also show that they understand the ways in which they can influence the results of an experiment depending on how the instrument is set up.

Higher National Unit specification: statement of standards (cont)

Unit title: Instrumental Techniques: Theory and Practice 2

Outcome 2

Perform experiments using a range of advanced analytical techniques

Knowledge and/or skills

- ◆ Calibrate the instrument
- ◆ Work in a safe manner in line with current health and safety practices
- ◆ Achieve accurate results
- ◆ Report the results clearly and concisely
- ◆ Evaluate the results in terms of their reliability and analytical significance

Evidence requirements

Evidence for this outcome will be provided by the candidate performing two practical assignments from the range suggested in the support notes. These assignments will allow outcomes 2 and 3 to be assessed. Emphasis should be on the student's performance in completing the laboratory work, their ability to produce satisfactory laboratory reports but particularly on their ability to discuss the results in terms of their analytical significance.

Assessment guidelines

It is recommended that the candidate should perform a range of practical assignments which can be used to assess outcomes 2 and 3. Only 2 practicals from those suggested in the support notes should be used for assessment purposes. Those selected for assessment purposes should allow the candidate to critically analyse the experimental results. This should allow the candidate to suggest changes to the instrument conditions, which will achieve better analytical results. It is suggested that a checklist be used to assess performance in the laboratory. This checklist should recognise the need for accuracy in analytical work. A laboratory report should also be produced to assess the candidate's ability to plan, analyse and discuss analytical work. Should a student fail to complete two assignments, they should be given the opportunity to attend further laboratory sessions. If the report is not of the required standard, remediation should be offered and a re-submission accepted.

Outcome 3

Develop methods to obtain optimum results from a range of analytical instruments.

Knowledge and/or skills

- ◆ Prepare analytical instruments for a range of experiments
- ◆ Critically discuss the analytical results
- ◆ Alter the analytical method in a way which improves the results

Higher National Unit specification: statement of standards (cont)

Unit title: Instrumental Techniques: Theory and Practice 2

Evidence requirements

The evidence for this outcome will be gathered using the experimental exercises designed to assess outcome 2. The candidate will be asked to describe the main factors, which they can change to alter the analytical results. They will be expected to alter at least one feature of the analytical process and run the experiment under the new conditions, reporting on the results of their changes.

Assessment guidelines

It is recommended that the candidate should perform a range of practical assignments which can be used to assess outcomes 2 and 3. Only 2 practicals from those suggested in the support notes should be used for assessment purposes. Those selected for assessment purposes should allow the candidate to critically analyse the experimental results. This should allow the candidate to suggest changes to the instrument conditions, which will achieve better analytical results. It is suggested that a checklist be used to assess performance in the laboratory. This checklist should recognise the need for accuracy in analytical work. A laboratory report should also be produced to assess the candidate's ability to plan, analyse and discuss analytical work. Should a student fail to complete two assignments, they should be given the opportunity to attend further laboratory sessions. If the report is not of the required standard, remediation should be offered and a re-submission accepted.

Administrative Information

Unit code:	DH2N 35
Unit title:	Instrumental Techniques: Theory and Practice 2
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Higher National Unit specification: support notes

Unit title: Instrumental Techniques: Theory and Practice 2

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 Applied Science and HND Biotechnology group awards. It should also be suitable for inclusion in other science HNC/HND awards. The aim is to give candidates the underpinning theoretical and practical knowledge of a range of instrumental techniques to allow them to contribute effectively in an analytical laboratory. They should be able to develop new analytical methods as well as troubleshoot when the analytical results are perhaps not what were expected.

Outcome 1

Candidates should be introduced to a range of more advanced instrumental techniques. It is expected that the recent advances in the design of spectrometers and chromatography instruments will form the main focus of this unit. For example if HPLC is a chosen technique candidates should be introduced to the difference between single stage and multistage pumps. This would then lead to a discussion on isocratic and gradient elution experiments and the advantages to be gained. In GC this discussion could focus on isothermal and temperature gradient experiments. In addition students could be introduced to the more advanced detectors now available such as Diode array or the combined techniques of GC-MS and more recently LC-MS.

There are a wide range of techniques, which could be discussed some of which have been mentioned above. It would be important to concentrate on techniques appropriate to the HNC/D discipline being studied. Emphasis should be placed on highlighting the factors under the control of the technician in the laboratory and how changing these can alter the analytical results. In chromatography this would almost certainly require discussion on the range of columns available, the various injection systems as well as the possible detectors which could be installed.

Typical techniques, which could be included in this unit, would be GC temperature programming, GC-MS, HPLC- gradient elution, LC-MS, NMR spectroscopy, 1D and 2D electrophoresis, PCR, Blotting techniques etc. Students should become familiar with the types of analyses performed on the various instruments, the overall design and the mode of operation of the main components.

Higher National Unit specification: support notes (cont)

Unit title: Instrumental Techniques: Theory and Practice 2

Outcome 2 and 3

Given the vocational nature of the HN awards these outcomes are crucial to the unit. Students should be given every opportunity to gain experience in programming and operating a wide range of instruments. 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 essential that students be allowed to alter instrument or experimental parameters and monitor the effect on the analysis. The more hands-on experience the students can be given the better. If it is possible they should be allowed to take part in some routine maintenance activity e.g. changing the column of a chromatography instrument, or the lamp of an Atomic Absorption Spectrometer.

On completing the unit students should feel confident that they could move into a laboratory position and be able to contribute to experimental design, method development and troubleshooting.

As stated above the range of practical exercises carried out should reflect the HN award being undertaken. Typical techniques are listed above. This should not be seen as an exhaustive list and lecturers should feel free to vary the techniques as appropriate. The emphasis should be on instrumentation and optimising the analytical results. It would not be appropriate to introduce practical work, which did not use some kind of instrumental technique.

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 post. The emphasis should be on encouraging the students to become familiar with a wide range of analytical techniques and applications. They should become aware of the range of options available within each particular technique, which could be used to alter the analytical results. They should be able to alter instrument or experimental conditions to obtain the most appropriate analytical results. In addition they should produce results to the required degree of accuracy.

Outcome 1 will be assessed using a case study, which requires the candidate to describe the range of options available to the analyst both in terms of alternative components and instrument programming, which could be used to improve the experimental design.

In outcomes 2 and 3 candidates will complete a series of practical exercises, 2 of which will be assessed. The exercises will be designed to allow the student to decide on certain experimental conditions and hence develop a method for the analyses. A combination of observation checklist and a written laboratory report should be used to assess the work.

Higher National Unit specification: support notes (cont)

Unit title: Instrumental Techniques: Theory and Practice 2

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. They should highlight the work they have done to optimise the analytical results, commenting on both successes and failures.

Should a candidate fail to carry out two experiments to the required standard, further attempts can be offered. Ideally candidates will be participating in several experiments, with only 2 required for assessment purposes.

Open learning

While it may be possible to deliver some of the material on instrument design by open learning, it is anticipated that candidates would have to attend classes to cover outcomes 2 and 3. If a candidate is employed in a laboratory based job then this practical work may well be part of their role. In such circumstances observation could take place in the workplace, and the appropriate laboratory report submitted to the college.

For further information and guidance, please see Assessment and Quality Assurance of Open and Distance Learning (SQA, February 2001, publication code A1030).

Special needs

This Unit specification is intended to ensure that there are no artificial barriers to learning or assessment. Special needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments or considering special alternative Outcomes for Units. For information on these, please refer to the SQA document *Guidance on Special Assessment Arrangements* (SQA, 2001).

General information for candidates

Unit title: Instrumental Techniques: Theory and Practice 2

This is a 1 credit SQCF level 8 unit, intended to be delivered as part of an HNC/HND science qualification. It is likely to be delivered in the second year of an HND programme. It is designed to give you the basic knowledge and practical skills you will need to undertake a role as a higher-grade technician in a wide range of science based industries. The emphasis will be on introducing you to the range of modern instruments used in laboratories.

On completion of this unit you should be able to

1. Describe the main factors within an instrument, which can be altered to optimise the analytical results.
2. Perform experiments using a range of advanced analytical techniques
3. Develop methods to obtain optimum results from a range of analytical instruments

The main component of the unit are described in more detail below:

Outcomes 1

You will be introduced to a range of advanced analytical techniques. The actual instruments discussed will depend on the nature of your course, but will include a selection from GLC, HPLC, electrophoresis systems and possibly a range of spectroscopy techniques. You will discuss the recent advances in instrument design and the ways in which this has improved the analytical results.

You will be expected to become familiar with the range of analytical techniques, especially the main aspects of the instruments which can be altered to change the analytical results. You will be expected to use this knowledge to decide on the most appropriate changes to the method to solve analytical problems.

Outcomes 2 and 3

In this outcome you will be expected to set up and operate a range of analytical instruments. You will carry out several practical exercises covering a range of analytical techniques. The emphasis will be on your ability to understand the nature of the analytical work being undertaken and to appreciate when the results are accurate and reliable. You will be expected to suggest changes to the methods which will improve on the instrument performance. In this unit the practical exercises are likely to take place over a few laboratory sessions, which will allow you to review results and decide on improvements to the experimental conditions. You will be expected to keep accurate records of all your work and to report this accurately and concisely