SQA Advanced Unit specification

General information for centres

Unit title: Laboratory Skills for Science Industries (SCQF level 7)

Unit code: HV0J 47

Superclass: RA

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Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to provide learners with the opportunity to learn and develop competency in the skills most commonly used in laboratories. Learners will gain practical experience in measuring and weighing quantities as well as basic laboratory skills relevant to their course of study. Maintaining health and safety in a laboratory environment is integral to the Unit. The Unit is suitable for learners studying at SQA Advanced Certificate level, and will provide the necessary practical and communication skills to enable progression to further study at SQA Advanced Diploma level or to seek employment in science based industries.

Outcomes

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

1 Apply key aspects of health and safety procedures in relation to science practical experiments.
2 Perform practical experiments related to science.
3 Demonstrate skills in interpretation of scientific information.
4 Demonstrate skills in scientific communication.

Credit points and level

2 SQA Unit credits at SCQF level 7: (16 SCQF credit points at SCQF level 7)

Recommended entry to the Unit

Entry is at the discretion of the centre, however it is recommended that learners should have completed or be in the process of completing the following SQA Advanced Units:

- HV00 47 *Fundamental Chemistry: Theory and Laboratory Skills*
- HT04 46 *Statistics for Science 1* or HV6N 46 *Mathematics for Science 1*

Core Skills

Achievement of this Unit gives automatic certification of the following Core Skills component:

Complete Core Skill	None
Core Skill component	Using Graphical Information at SCQF level 6 Critical Thinking 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.

Understanding Standards materials have been developed to assist the delivery of this Unit and to provide advice on general assessment and marking principles. These materials are available securely at the SQA Understanding Standards website **(http://www.understandingstandards.org.uk)**.

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

Unit title: **Laboratory Skills for Science Industries (SCQF level 7)**

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

Apply key aspects of health and safety procedures in relation to science practical experiments.

Knowledge and/or Skills

- Legal requirements for health and safety
- Assessment of hazardous substances
- Risk assessment

Outcome 2

Perform practical experiments related to science.

Knowledge and/or Skills

- Science practical laboratory techniques
- Science experiments
- Working safely, within current health and safety regulations
- Consistent and accurate results
- Recording observations and results
- Evaluation skills
- Result analysis and conclusions

Outcome 3

Demonstrate skills in interpretation of scientific information.

Knowledge and/or Skills

- Scientific graphical formats
- Analysing scientific information and interpretation techniques

Outcome 4

Demonstrate skills in scientific communication.

Knowledge and/or Skills

- Laboratory report writing
- Poster production
- Presentation skills

Evidence Requirements for this Unit

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills across all Outcomes.

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:

- Produce a minimum of two assessments of different types of hazardous substances in line with current legislation.
- Produce a minimum of two risk assessments.

Each assessment must demonstrate an understanding of the legal requirements for health and safety in relation to the practical experiment which the learner is to carry out.

Outcome 2

Learners will perform a minimum of four practical experiments to develop competence in techniques utilised in science experiments.

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

- Follow instructions to perform a range of practical laboratory techniques related to science.
- Follow instructions to perform experiments related to science.
- 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.

The content of one of the practical experiments must be related to chemistry, with the content of at least one other practical experiment being related to biology or physics.

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 will record all results and relevant observations relating to the practical laboratory techniques in a laboratory diary. The laboratory diary will follow the fundamentals of Good Laboratory Practice (GLP).

Learners will record all results and relevant observations relating to practical experiments in a laboratory diary and pro forma. The pro forma should 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.

Learners will be required to measure experimental parameters, with relevant units and significant figures as appropriate, and on at least one occasion to calculate magnitude of experimental errors.

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 diary and/or pro forma 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.

Outcome 3

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

- Present scientific data using two appropriate graphical formats.
- Analyse and interpret scientific information from a range of sources.

Learners will be required to produce one line of best fit graph and one other graphical format to appropriate standards. One graph must be produced by the learner and the other graph must be produced using a computer software package (eg Excel).

Where a learner does not produce a graph to the required standard, they will be given the chance to either reattempt the same graph, or to undertake a different graph of similar complexity. If the required standard is still not attained, then alternative scientific data will be set.

Learners will be required to analyse and interpret numerical data, graphical information and scientific text from a range of sources, including laboratory and published sources. Learners will be required to analyse both numerical and text based datasets to identify trends and reach valid conclusions.

Where a learner does not analyse and interpret scientific information to the required standard, they will be given the chance to either reattempt the same analysis and interpretation, or to analyse and interpret scientific information of similar complexity. If the required standard is still not attained, then alternative analysis and interpretation of scientific information will be set.

Outcome 4

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

- Produce a minimum of three scientific laboratory reports.
- Produce a poster on a scientific topic.
- Produce and deliver an oral presentation on a scientific topic.

Learners will be required to produce a laboratory report on at least three occasions containing title, aim, introduction, experimental method, results/ raw data, calculations (where appropriate), conclusion, discussion (where appropriate) and evaluation/ sources of error. The report must be in the impersonal voice, past tense and have an appropriate structure.

Where a laboratory report 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.

Learners will be required to produce a poster on a scientific topic containing title, introduction, analysis and interpretation of information and/or data, conclusions and references. The poster must be in an electronic format and be in the impersonal voice, past tense and have an appropriate structure. Learners should produce an abstract to accompany the poster.

Where a learner does not produce a poster to the required standard, it is recommended that they be given constructive criticism. After feedback, learners can be given the chance to either reattempt the same topic, or to undertake a different topic of similar complexity.

Learners will be required to deliver an oral presentation on a scientific topic to an audience. Learners will decide, in consultation with their lecturer, the topic to be presented. The presentation will be for a minimum of five minutes, and a learner's response will be judged satisfactory where the evidence shows that the learner can:

- Select accurate and relevant scientific information, and structure the presentation appropriately for purpose and audience.
- Produce visual aids appropriate for purpose and audience and use these aids effectively in the presentation.
- Use appropriate tone, pace and non-verbal communication, ensuring the presentation is clear and audible.

An assessor observation checklist and/or video recording, and support materials (eg PowerPoint) should be retained as evidence of performance for each learner.

Where a learner does not deliver a presentation to the required standard, it is recommended that they be given constructive criticism. After feedback, learners can be given the chance to either reattempt the same topic, or to undertake a different topic of similar complexity.

SQA Advanced Unit Support Notes

Unit title: Laboratory Skills for Science Industries (SCQF level 7)

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 80 hours.

Guidance on the content and context for this Unit

This Unit is a mandatory Unit in the frameworks for the SQA Advanced Certificate/Diploma in Applied Sciences, the SQA Advanced Diploma in Applied Biological Sciences and the SQA Advanced Diploma in Chemical Sciences, but may be suitable for inclusion in other SQA Advanced Science awards. It is designed to develop practical scientific skills to enable progression to further study or to support the study of such skills in the workplace.

In Outcome 1 learners should be given a brief overview of relevant health and safety legislation. The exact legislation to be covered will vary depending on the nature of the course in which the Unit is delivered. Learners should be given guidance, with appropriate examples, of how to correctly complete and understand assessment of hazardous substances (for example Control of Substances Hazardous to Health (COSHH) or Ionising Radiation) and risk assessments in line with current legislative requirements.

The four major classes of hazard (chemical, physical, biological, ergonomic) should be covered, in appropriate detail to the nature of the course in which the Unit is delivered. Attention should be given to concepts such as short and long term effects and routes of entry.

Learners should be given details on the design and meaning of signs and hazard symbols, and on the extraction of information from Material Safety Data Sheets.

In Outcome 2 learners will be given the opportunity to develop expertise in following practical instructions, utilising scientific equipment, working in a safe manner, attaining accuracy and consistency and evaluation of results including handling of experimental errors. Learners will record evidence of undertaking these practical laboratory techniques by means of a laboratory diary prior to undertaking the assessed practical experiments.

Learners will undertake practical experiments related to chemistry plus either biology and/or physics. 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 develop their laboratory skills.

In carrying out such practical experiments, learners should follow the fundamentals of Good Laboratory Practice (GLP) and carry out or be familiar with the assessment of laboratory hazards in line with current health and safety legislation on all procedures undertaken.

The practical experiments should require learners to measure experimental parameters utilising equipment of suitable accuracy and tolerances for the task in hand.

In Outcome 3 learners will be required to present scientific data using appropriate graphical formats to include one line of best fit graph and one other appropriate graphical format (eg bar chart, histogram, pie chart). One graph must be produced by the learner and the other graph must be produced using a computer software package (eg Excel). Appropriate standards would include title, axis labels, units, x- and y-axes scale choice.

Learners will analyse and interpret scientific information from a range of sources, eg experimental laboratory data, scientific journals, news items, books.

Outcome 4 is primarily intended to provide the learner with a practical introduction to, and understanding of, the main formats by which scientific information is communicated. The essential underpinning knowledge and skills gained will be invaluable to learners during employment or further study. The learner should attain the level of written and oral competence required to produce and present scientific information in a professional situation. Emphasis is on the development of transferable skills rather than on knowledge of the scientific topics used during the delivery of the Unit.

Guidance on approaches to delivery of this Unit

There is no particular order in which Outcomes 1−4 would be best delivered.

It is envisaged that the Unit could be delivered as a standalone Unit, or embedded within other Units of an SQA Advanced Science award. Centres may choose to integrate selected Outcomes within other SQA Advanced Units.

Learners should be allocated sufficient laboratory time to allow them to develop competence in underpinning practical laboratory techniques prior to attempting the assessed practical experiments.

Practical laboratory techniques to be covered could include:

- Use of pipettes and burettes
- Titrations
- Preparation of standard solutions
- Melting point determination
- Reflux or distillation
- Solvent extraction
- Recrystallisation
- Chromatography
- Use of automatic pipettes
- Serial dilution
- Preparation and staining of microscope slides
- Oil immersion microscopy
- Use of a microscope
- Subculture of micro-organisms
- Pouring plates
- Use of a spectrophotometer
- Gel electrophoresis
- Centrifugation
- Cell culture
- Measuring mass
- Measuring volume
- Use of pH meter
- Reading of an oscilloscope
- Reading of a multimeter
- Setting up circuits
- Measuring temperature with a thermocouple
- Measuring distance with a micrometer
- Reading a vernier scale
- Use of a spectrometer
- Measuring angles of reflection and refraction
- Use of light gates
- Use of linear air tracks

Centres should ensure that learners develop experience performing a wide range of practical laboratory techniques. As the purpose of the learners undertaking these practical laboratory techniques is to allow them to develop competence, it is not intended that accuracy will be critical at this stage. Learners will record evidence of undertaking these practical laboratory techniques by means of a laboratory diary prior to undertaking the assessed practical experiments.

Once learners have developed the necessary practical skills, they would then proceed to undertake the assessed practical experiments, which they should be then able to perform independently and to a high degree of accuracy.

Learners should be encouraged to develop their awareness of key aspects of health and safety and Good Laboratory Practice (GLP) throughout the practical activities.

Learners should be supported in developing competence in the presentation of scientific data, the analysis and interpretation of scientific information and a broad range of scientific communication techniques.

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 1−4 could be assessed by a portfolio-based approach which could utilise evidence from other SQA Advanced Units.

Assessed activities will usually be performed individually. However, there may be some activities 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.

Examples of suitable practical experiments are given below. However, this list is not prescriptive, and other practical experiments of similar complexity may be used by the centre.

Chemistry

- Volumetric analysis — involving acid/base, redox, precipitation and titrations.
- Serial dilution calculations and techniques.
- Gravimetric analysis, which could include organic precipitants.
- The synthesis of inorganic or organic compounds. This could include the use of reflux, distillation, extraction, recrystalisation, mpt and bpt determination.

Biology

- Haematoxylin and Eosin staining of tissue sections.
- Comparing structure and size of plant, animal and bacterial cells.
- Gram-stain of bacteria samples.
- Identify an unknown biological molecule from its chemical and physical properties. For example — identification of an unknown carbohydrate using a variety of biochemical test.
- Extraction of nucleic acid from animal or plant cells.
- Perform an enzyme assay (eg alkaline phosphatase) using visible/UV spectrophotometry to follow enzyme reactions directly or through coupled reactions.
- Investigate the light dependent reaction in photosynthesis by measuring reduction of DCPIP.
- Investigate yeast dehydrogenase activity in the presence of different substrates.

Physics

- Doppler effect.
- Snell's law, refraction of light through a glass block.
- Optical polarisation and Brewster's angle.
- Wavelength of light.
- Measuring the refractive index of air using a Michelson interferometer.
- Dividing the amplitude of laser light.
- Interference by dividing the amplitude using a thin air wedge.
- Measuring viscosity of water using a capillary tube and Poiseuille's Equation.
- Measuring the viscosity of glycerol.
- Measuring Young's modulus.

An exemplar instrument of assessment with marking guidance has been produced to indicate the national standard of achievement at SCQF level 7.

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

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.

***Numeracy* — Using Number at SCQF level 6**

Learners will be required to decide on the steps and operations to solve complex problems, carrying out sustained and complex calculations, eg performing calculations related to cell size or performing calculations related to percentage yields of reactions and calculations of pH.

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 and pro formas in an appropriate format. Packages used will likely include word processing, spreadsheets, graph drawing software and specialist chemical structure software. Learners will also be required to utilise internet search engines to source information on research topics.

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.

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

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: Laboratory Skills for Science Industries (SCQF level 7)

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 2-credit Unit at SCQF level 7, which you are likely to be studying as part of the first year of an SQA Advanced science programme.

On completion of the Unit you should be able to:

1 Apply key aspects of health and safety procedures in relation to science practical experiments.
2 Perform practical experiments related to science.
3 Demonstrate skills in interpretation of scientific information.
4 Demonstrate skills in scientific communication.

Outcome 1

In this Outcome you will learn about health and safety legislation in relation to science practical experiments. You will cover the four main classes of hazard (chemical, physical, biological, ergonomic) and you will learn how to correctly complete and understand the assessment of laboratory hazards in line with current legislative requirements. You will also cover the design and meaning of signs and hazard symbols.

Outcome 2

In this Outcome you will be allocated laboratory time to develop skills in practical laboratory techniques utilised in science experiments. You will be given the opportunity to develop expertise in following practical instructions, utilising scientific equipment, working in a safe manner, attaining accuracy and consistency and evaluation of results including handling of experimental errors.

During this practical work you will follow the fundamentals of Good Laboratory Practice (GLP) and carry out or be familiar with the assessment of laboratory hazards in line with current legislative requirements on all procedures undertaken.

Outcome 3

In this Outcome you will learn how to present scientific data using appropriate graphical formats. You will also learn how to analyse and interpret scientific information from a range of sources, eg experimental laboratory data, scientific journals, news items, books.

Outcome 4

In this Outcome you will be introduced to the main formats by which scientific information is communicated — laboratory report writing, poster production and oral presentation. You will attain the level of written and oral competence required to produce and present scientific information in a professional situation.

Assessment

For Outcome 1 you will produce two assessments of hazardous substances and two risk assessments.

Outcome 2 will be assessed by your performance of practical laboratory techniques and the recording of these in a laboratory diary. You will also undertake four assessed practical experiments, for which you will report your results in pro formas.

For Outcome 3 you will present scientific data using appropriate graphical formats, to include one line of best fit graph and one other appropriate graphical format (eg bar chart, histogram, pie chart). In addition, you will analyse and interpret numerical data, graphical information and scientific text from a range of sources, including laboratory and published sources.

For Outcome 4 you will produce three laboratory reports based on experiments that you have carried out, and a poster on a scientific topic. In addition, you will deliver an oral presentation to an audience on a scientific topic.

Core Skills

This Unit has the Core Skills of *Critical Thinking* and *Using Graphical Information* at SCQF level 6 embedded in it.