

Unit 1: Best practice in science (LEVEL 2)

Learning outcomes

By completing this unit candidates will develop a thorough knowledge and understanding of the skills necessary to undertake scientific research. Candidates will be able to carry out routine laboratory activities using prescribed standard operating procedures in accordance with approved statutory regulations and organisational safety requirements.

Candidates will produce evidence to meet the unit objectives in order to show that they have the skills to:

- follow standard procedures in a safe manner
- prepare laboratory materials, equipment and resources
- carry out sampling operations
- carry out testing operations
- work in aseptic or clean room conditions
- produce a report for relevant people.

Assessment objectives	Knowledge, understanding and skills
1 Identify the statutory regulations and organisational procedures to maintain safety	<p>Maintain health and safety in work area:</p> <ul style="list-style-type: none">• health, safety and environmental regulations• COSHH data (Control of Substances Hazardous to Health Regulations)• hazard symbols• describe safe working procedures linked to each hazard symbol• hazards in the work place <p>Follow codes of practice:</p> <ul style="list-style-type: none">• safety regulations in the workplace• first aid procedure• fire procedures• guidelines on how information is communicated• identify the relevant people within the codes <p>Follow safety procedures:</p> <ul style="list-style-type: none">• prevent hazards when working• wear appropriate protective clothing• carry out risk assessments for ALL procedures• know why standard procedures are used in the workplace <p>Carry out personal responsibilities:</p> <ul style="list-style-type: none">• maintain safe work environment• individual working responsibilities <p>Use ICT sources or tools to either gather or present data.</p>

Assessment objectives	Knowledge, understanding and skills
<p>2 Carry out sampling operations and prepare materials and equipment for testing activities</p>	<p>Prepare sampling and testing equipment</p> <ul style="list-style-type: none"> • correct equipment is serviceable • equipment is clean • utilities are appropriate and serviceable <p>Establish measurement requirements</p> <ul style="list-style-type: none"> • identify correct units of measurement to use • identify correct equipment to take measurements <p>Calibration of equipment</p> <ul style="list-style-type: none"> • principles of calibration • calibration procedure • acceptable tolerances <p>Methods of sampling</p> <ul style="list-style-type: none"> • standard procedures for sampling • sampling plan • label and record of samples • store and transport of samples safely
<p>3 Perform laboratory activities and carry out testing operations safely</p>	<p>Control test conditions</p> <ul style="list-style-type: none"> • maintain a safe and clean environment • exclude external variances or contamination by keeping the environment clean or aseptic <p>Integrity and identification of samples</p> <ul style="list-style-type: none"> • maintain the samples free from defect, damage or decomposition • identification is recognised by labelling and records <p>Test procedure</p> <ul style="list-style-type: none"> • follow standard procedures for testing • maintain the reliability and sensitivity of the test <p>Understand the purpose of working in an aseptic or clean room</p> <ul style="list-style-type: none"> • maintain sterility and cleanness • follow standard aseptic procedure
<p>4 Record test results</p>	<p>Calculation of test results</p> <ul style="list-style-type: none"> • carry out any required calculations • comment on the accuracy of results <p>Presentation of results</p> <ul style="list-style-type: none"> • presented to meet the needs of an identified end user <p>Documentation</p> <ul style="list-style-type: none"> • needs to be accurate/and legible • in a format for an identified end user <p>For example:</p> <ul style="list-style-type: none"> • performance report • pass/fail sheet • test records • quality assurance form

Assessment objectives	Knowledge, understanding and skills
5 Use standard procedures to store and dispose of resources safely	Storage of resources <ul style="list-style-type: none"> • need to be safe • in a regulation location • clearly identified Waste disposal <ul style="list-style-type: none"> • standard procedures to be followed for breakages • standard procedures to be followed for the disposal of both chemical and biological wastes • disposal records to be maintained
6 Consider how best practice in science has developed over time and where it may be in the future	Operating procedures have evolved and are likely to change in the future, such as: <ul style="list-style-type: none"> • use of ICT databases • safety procedures • health procedures • clean room procedures • global integration of procedures via telecommunications Evolution in data collection tools and its justification. For example: <ul style="list-style-type: none"> • use of ICT in data logging • computer modelling and simulation • instrumentation • animal testing

Assessment

This unit is centre-assessed and externally moderated.

In order to achieve this unit candidates must produce a portfolio of evidence showing that they can meet all of the assessment objectives.

Portfolios of work must be produced independently. They will need to be made available, together with witness statements and any other supporting documentation, to the OCR Visiting Moderator when required.

Centres must confirm to OCR that the evidence produced by candidates is authentic. An OCR Authentication Form is provided in the Centre Handbook and includes a declaration for assessors and candidates to sign. It is a requirement of the QCA Common Criteria for all Qualifications that proof of authentication is received.

Guidance on assessment and evidence requirements

Tutors should at all times make sure that candidates comply with any safety considerations that have been published by any regulatory body (refer to COSHH regulations, CLEAPPS handbook and CLEAPPS: hazard and student safety sheets). There may also be relevant safety regulations issued by the DfES or local LEAs, as well as by the institution that the course is being carried out in, that need to be considered.

Candidates could use evidence from other units and map this to the assessment objectives within this unit, instead of undertaking a separate investigation. **However, those candidates working**

towards the higher grades would be expected to use evidence from a single investigation to meet the assessment objectives for this unit.

For their portfolio, higher level candidates will present evidence from a complete investigation, which requires at least five structured tasks, set in a scenario. This will enable them to place their practical work in a realistic vocational context. This will enable candidates to link classroom activities to career paths.

Examples of contexts where skills from this unit are used could include:

- environmental water testing - local council environmental department testing bathing/paddling water in a public park after local residents have complained of children's illness after visiting the park
- swimming pool testing - pool attendant's job of continuously monitoring the water quality
- environmental soil testing of a brownfield site - environmental agency testing future building land
- soil testing - prior to an archaeological dig of a lead working site
- forensic science - analysis of a crime scene
- ore site analysis - analysis both for economic and safety reasons
- drink analysis - analysis for environmental health.

Following standard procedures is the way most scientists at technician level work. However, as well as following instructions correctly, they need to be able to 'troubleshoot', taking remedial action when problems arise, and to think about the significance of their results. The vocational relevance can be enhanced by using standard procedures obtained from local organisations.

Working safely in science is of great importance. Candidates must be aware of and abide by the safety regulations for the laboratory in which they are working. They should be encouraged to use the safety reference sources for themselves and demonstrate that they can carry out the risk assessment relevant to the activity they are doing.

An OCR model assignment is available for this unit. It can be downloaded from our website: www.ocr.org.uk and can also be found in the Model Assignments folder on this CD Rom.

Identifying the statutory regulations and organisational procedures to maintain safety (AO1)

It is important that candidates realise the importance and legality of working safely. They should have an understanding of the basis of British health and safety law, which is **the Health and Safety at Work Act 1974** and the relative importance of three components (guidance, approved codes of practice and regulations) when implementing health and safety procedures.

Candidates should record the section of the Health and Safety at Work Act 1974, COSHH data CLEAPPS hazard and student safety sheets, and Hazard symbols relevant to the activity they are carrying out. The First aid and fire procedures relating to the laboratory in which they are working should also be submitted within their portfolio. Candidates should be aware of the reasons for using standard procedures in the workplace and the importance of consistency.

Candidates **must** use ICT sources or tools to either gather or present their data.

To evidence the requirements of this assessment objective, candidates could produce:

- an electronic presentation on safe working in the laboratory
- risk assessments to all laboratory activities.

Carry out sampling operations and prepare materials and equipment for testing activities (AO2)

Routine sampling activities using prescribed standard operating procedures are the starting point of an analytical investigation. Candidates will appreciate the need for a sampling plan to give meaning to the results after testing. Samples will need to be prepared, with the candidates choosing the right equipment to do the job.

To demonstrate this, candidates need to:

- produce a sampling plan ensuring the conditions for sampling are safe
- collect and document samples.

Observations and measurements also need to be sound and consistent in order to be reliable. Therefore, if a candidate measures the width of an object, another candidate or the same candidate should obtain the same values when repeating measurements. Another aspect of reliability is that they would both measure the same dimension, for example 'width' rather than some other dimension of the object. Tutors can encourage candidates to be good experimenters and to try to make their results reliable by:

- selecting the best instrument for the job (or the best scale on an instrument)
- encouraging good technique (using instruments correctly, perhaps cross-checking with others)
- encouraging good experimental design (designing a fair test).

When making observations or measurements candidates should select the appropriate instrument that will give the required accuracy and precision, where 'Accuracy' means how close the measured quantity is to the true value and 'Precision' is the necessary degree of refinement required by measurements and observations with a specified instrument.

Candidates will realise that measuring equipment needs to be calibrated. They will need to:

- carry out calibration at specified intervals according to standard operating procedures
- comment on the accuracy of their results.

Perform laboratory activities and carry out testing operations safely (AO3) and Record test results (AO4)

Candidates will learn and practise important practical skills that they can apply across their work in other units. In this unit they will carry out simple testing activities, which will involve:

- checking equipment and conditions for testing – which may require clean or aseptic conditions
- conducting tests safely – candidates need to carry out:
 - a chemical analysis
 - microscopic identification by observing fine detail with a microscope
 - micro-organic identification by agar plating
- recording test results, analysing them and commenting on their accuracy
- evaluating the reliability and limitations of the tests themselves.

Evidence for these assessment objectives would be based on the candidates' laboratory notes in which they have:

- risk assessments for carrying out tests
- an explanation of the use of aseptic technique
- explanations of the tests carried out
- labelled diagrams using conventional format for microscopic observations
- a record of agar plating results either as a image or as text
- an evaluation of all tests carried out.

Use standard procedures to store and dispose of resources safely (AO5)

Working safely and effectively in science requires all candidates to follow instructions correctly and to handle materials and equipment competently. This will be demonstrated by the candidate's approach to activities and be reflected in the Tutor's grade assessment for the candidate.

Candidates should be given opportunities not only to develop scientific skills, but to explore how and for what they are used. This will enable candidates to place their practical work in a realistic vocational context.

To this end candidates could link their testing activities to those carried out in a particular scientific organisation. Ideally this should be achieved through a balanced program of visits to places where scientists are employed, to see laboratory skills in practice, hear from skilled practitioners and look at relevant resources, such as manuals and experimental procedures.

Evidence might be in the form of a comparison of candidates' actual procedures against those used in a scientific organisation.

Consider how best practice in science has developed over time and where it may be in the future (AO6)

This is a reflective assessment objective that requires candidates to investigate how procedures in best practice originated and how they have evolved. Candidates should be aware of the ways in which operating procedures and data collection tools are evolving.

This assessment objective could be evidenced by a report or presentation, where candidates talk about these issues in general terms. Alternatively, candidates could examine how best practice developed, and is developing, in a particular organisation. Where this is the case, evidence could be presented as a report or presentation that describes how an organisation carries out best practice in practical scientific enquiry, data collection and analysis and how best practice might develop in the future.

Signposting to Key Skills

- ✓ The unit contains opportunities for developing the Key Skill, and possibly for generating portfolio evidence, if teaching and learning is focused on that aim. Assessing staff will need to check each candidate's evidence against the specifications to ensure all evidence requirements have been met. Additional evidence may also be required.

Key Skill reference		Key Skill reference		Key Skill reference	
C2.1		N2.1	✓	ICT2.1	✓
C2.2a	✓	N2.2a	✓	ICT2.2	✓
C2.2b	✓	N2.2b	✓	ICT2.3	✓
C2.3	✓	N2.2c	✓		
		N2.2d			
		N2.3	✓		

Mapping to National Occupational Standards

Occupational Standards	Unit number	Title
LATA	1.01	Complying with Statutory regulations and Safety requirements
LATA	1.04	Take laboratory measurements
LATA	1.05	Perform basic laboratory activities
LATA	2.03	Carry out simple testing operations
LATA	2.04	Carry out simple sampling operations
LATA	2.05	Prepare laboratory materials, equipment and resources
LATA	2.06	Calibrate equipment
LATA	2.13	(Cogent 1.8) Work in aseptic or clean room conditions

Resources

The following are suggestions of resources that could be useful when delivering the unit. They are neither prescriptive nor exhaustive, and candidates should be encouraged to gather information from a variety of sources.

Books

DfES (1996)	<i>Safety in Science Education</i> The Stationery Office Books
Dept of Education and Science (1985)	<i>Microbiology: A guide for schools and non-advanced further education</i> The Stationery Office Books
CLEAPSS Laboratory Handbook (updated 2005)	See URL:http://www.cleapss.org.uk/ for details
CLEAPSS Hazcards (updated 2005)	See URL:http://www.cleapss.org.uk/ for details

Journals/Magazines/Newspapers

Protocols and standard operating procedures from local organisations.

Science teachers should be familiar with the requirements of COSHH Regulations, with DfEE (DES) memoranda on the use of plants and animals in schools and with regulations applying locally. For information contact science advisor/education department.

Websites

The CLEAPSS School Science Service. URL:<http://www.cleapss.org.uk/>

The Consortium of Local Education Authorities for the Provision of Science Services is an advisory service for subscribers able to help from nursery education through to A Level or equivalent. CLEAPSS guidelines give detailed advice on microbiology, with suggestions for useful reference material.

The National Centre for Biotechnology Education, The University of Reading.

URL:<http://www.ncbe.reading.ac.uk/> The NCBE develops innovative educational resources, including suggestions for investigations.

Society for General Microbiology. URL:<http://www.socgenmicrobiol.org.uk/>

Provides a common meeting ground for scientists working in research and in fields with applications in microbiology.

Royal Society of Chemistry. URL:<http://www.rsc.org/>

The RSC is the largest organisation in Europe for advancing the chemical sciences and activities span education, conferences, science policy and the promotion of chemistry to the public.

CRAC Career development for life. URL:<http://www.crac.org.uk/>

The Careers Research and Advisory Centre aims to advance the education of the public, and young persons in particular, in lifelong career-related learning.

Health & Safety Executive. URL:<http://www.hse.gov.uk/>

Aims to protect people's health and safety by ensuring risks in the changing workplace are properly controlled. Includes publication information.

Grading

Assessment Objective	Pass	Merit	Distinction
AO1 Identify the statutory regulations and organisational procedures to maintain safety	Candidates demonstrate a basic understanding of the statutory regulations and organisational procedures for laboratory working and have some understanding of the health and safety consequences of non-compliance. Candidates use ICT sources or tools to either gather or present their data.	Candidates demonstrate a detailed understanding of the statutory regulations and organisational procedures for laboratory working and they understand the health and safety consequences of non-compliance. Candidates use ICT sources or tools to either gather or present their data.	Candidates demonstrate a thorough understanding of the statutory regulations and organisational procedures for laboratory working and they fully understand the health and safety consequences of non-compliance. Candidates use ICT sources or tools to either gather or present their data.
AO2 Carry out sampling operations and prepare materials and equipment for testing activities	Candidates demonstrate a basic competence in preparing samples and testing equipment, establishing measurement requirements, calibrating equipment and using different methods of sampling. They also comment in basic terms on the validity and reliability of the collected data.	Candidates demonstrate competence in preparing samples and testing equipment, establishing measurement requirements, calibrating equipment and using different methods of sampling. They also comment in detail on the validity and reliability of the collected data.	Candidates demonstrate high level of competence in preparing samples and testing equipment, establishing measurement requirements, calibrating equipment and using different methods of sampling. They also comment in great detail on the validity and reliability of the collected data. Their evidence is also well structured .
AO3 Perform laboratory activities and carry out testing operations safely	Candidates demonstrate a basic level of competence when conducting tests but they will have some understanding of the importance of maintaining a safe and clean working environment.	Candidates demonstrate competence when conducting tests and have a sound understanding of the importance of maintaining a safe and clean working environment.	Candidates demonstrate a high level of competence when conducting tests and have a thorough understanding of the importance of maintaining a safe and clean working environment.

Assessment Objective	Pass	Merit	Distinction
AO4 Record test results	Candidates present their results in a format which is brief . The calculation of test results has been conducted qualitatively or the most easily obtainable quantitative data has been used.	Candidates present their results in a format which is detailed and structured . The calculation of test results has been conducted quantitatively and is generally accurate .	Candidates present their results in a format which is very detailed and very well structured . The calculation of test results has been conducted quantitatively and is accurate .
AO5 Use standard procedures to store and dispose of resources safely	Candidates demonstrate a basic competence in storing and disposing of resources safely and have some understanding of the importance of maintaining a hazard-free working environment.	Candidates demonstrate competence in storing and disposing of resources safely and they have a clear understanding of the importance of maintaining a hazard-free working environment.	Candidates demonstrate a high level of competence in storing and disposing of resources safely and they will have a thorough understanding of the importance of maintaining a hazard-free working environment.
AO6 Consider how best practice in science has developed over time and where it may be in the future	Candidates describe in basic terms how best practice in science, in terms of operational procedures and data collection, has evolved and how it might develop in the future. They present their evidence in a format which is brief .	Candidates describe in detail how best practice in science, in terms of operational procedures and data collection, has evolved and how it might develop in the future. Their evidence is clearly structured .	Candidates describe in great detail how best practice, in terms of operational procedures and data collection, has evolved and how it might develop in the future. Their evidence is very well structured .