Unit Reference Number	H/505/3096
Title	Practical techniques in science
Unit number	4
Unit Level	2
Guided Learning Hours	30
Unit Credit Value	5

Learning Outcome (LO) The learner will:		**Pass** The Assessment criteria are the pass requirements for this unit. The learner can:		**Merit** To achieve a merit the evidence must show that, in addition to the pass criteria, the learner is able to:		**Distinction** To achieve a distinction the evidence must show that, in addition to the pass and merit criteria, the learner is able to:	
LO1	Know how organisations and individuals use science to identify hazards and minimise risk.	P1	demonstrate an awareness of the statutory regulations and organisational practices used to identify hazards and minimise risk	M1	describe the measures taken by an organisation in the science sector to ensure compliance with the statutory regulations		
		P2	outline a risk assessment with reference to appropriate statutory regulations	M2	define and perform a standard procedure based on the risk assessment		
LO2	Know how to use practical techniques in scientific work, in the laboratory and the field, to maintain the quality of the sample and avoid contamination of the laboratory and/or the environment.	P3	identify some of the techniques required to maintain the quality of the sample and avoid contamination of the laboratory and/or the environment	M3	describe some of the techniques required to maintain the quality of the sample and avoid contamination of the laboratory and/or the environment	D1	explain the importance of some of the techniques required to maintain the quality of the sample and avoid contamination of the laboratory and/or the environment

Aim of the unit

By completing this unit, learners will understand the need for common, standard procedures in all workplaces that use science. Learners will know how to use techniques to ensure that the samples they are collecting, testing and analysing are handled appropriately, and both the samples and environment in which they are working, are kept free from contamination.

Learners will be able to define procedures used by organisations and individuals that use science to identify hazards and minimise risk.

Teaching content

The unit content describes what has to be taught to ensure that learners are able to access the highest grade.
Anything which follows an i.e. details what must be taught as part of that area of content.
Anything which follows an e.g. is illustrative, it should be noted that where e.g. is used, learners must know and be able to apply relevant examples to their work though these do not need to be the same ones specified in the unit content.

LO1 Understand how organisations and individuals use science to identify hazards and minimise risk.

- Defining hazard and risk
- Identification of hazards:
  - International hazard symbols
  - Biological hazards
  - Chemical hazards
  - Physical hazards
- Ways of minimising risk:
  - In transport; storage
  - Use in the laboratory
  - Use in the field, e.g. Ecological work, scene of crime investigations
- Legislation and organisational procedures:
  - The Health and Safety at Work Act, 1974;
  - COSHH, 2002
  - RIDDOR, 1995
  - International hazard symbols
  - Local laboratory rules and codes of practice
  - Risk assessments

- CLEAPSS

LO2 Know how to use practical techniques in scientific work, in the laboratory and the field, to maintain the quality of the sample and avoid contamination of the laboratory and/or the environment.

- Collection techniques:
  - For biological specimens, e.g. Syringe, swab, forceps, pooter, net, sticky tape for forensic trace samples
  - For chemical and physical samples, e.g. Spatula, pipette, syringes, tube samplers, corers and augers, chisels, hammers, drills, saws
  - Use of protective clothing, where appropriate.
- Handling of samples:
  - Labelling
  - Storage of samples to maintain their integrity and/or prevent deterioration (in container made from appropriate material; secure containers; store at appropriate temperature); security, where appropriate
  - Limiting contamination of sample (protective clothing, where appropriate; level of cleanliness of equipment for biological specimens, for forensic evidence; washing techniques for analytical equipment; aseptic technique for microorganisms)
  - Limiting exposure of the person handling sample (use of protective clothing e.g. Gloves, respirator, use of fume cupboard/hood).
- Treatment of samples so as to limit contamination of the environment:
  - Aseptic technique when working with microorganisms
  - Working with samples in the field
  - Working with hazardous chemicals
  - Disposal.

Learners working at all levels should be given the opportunity to collect a range of different types of sample, and label them, store them, and handle them appropriately during the analysis that follows. The collection of a suitable range of 'forensic' evidence would provide an opportunity to use an appropriate range of techniques, and in this context, learners will appreciate the importance of handling samples carefully.
Those learners working at Distinction level should be able to articulate clearly, in a scientific manner, the importance of using the measures adopted.

Delivery guidance

Learners should gain knowledge, understanding and skills through their own practical research as well as that from the scientific community. This unit can be linked with the any of the optional units in Biology, Chemistry and Physics.

If working as a team, learners should ensure that they have identified their contribution to the planning and execution of any task involving teamwork. This should be supported by a witness statement from the tutor. If learners are working as a team this presents the opportunity for individuals to draw on their strengths and also to develop new skills.

The principles of this unit should be developed through formal tutor input but these should be exemplified by a series of appropriate activities (practical and theoretical). These may be taken from other optional units, or other contexts in Biology (e.g. testing samples for contamination with microorganisms; microscopical examination; testing fitness; monitoring the growth of organisms), Chemistry (e.g. testing water samples; analysing samples quantitatively; testing forensic samples; chromatography) and Physics (e.g. testing the electrical resistance or conductance of materials; materials testing), but could alternatively cover areas such as ecology (e.g. surveying a habitat; measuring species distribution), forensic science (e.g. fingerprinting techniques; DNA techniques) or microbiology (e.g. testing antimicrobial agents).

LO1 Understand how organisations and individuals use science to identify hazards and minimise risk.

Learners should understand that a hazard is a chemical, organism or body sample, piece of equipment, the physical condition of an object, or an activity, that has the potential to do harm. A risk is the likelihood of a hazard causing harm in the circumstances in which it is being used.

Identification of potential hazards and the risks associated with them are key to the management of risk. For chemical and certain other hazards, there is an international set of hazard symbols for universal recognition.

Identification of hazards, risks, ways of minimising risk, and emergency procedures, form the basis of a risk assessment. A risk assessment is performed before any practical work is undertaken. This could be for a standard laboratory activity, working in the field, e.g. when undertaking ecological work, or before entering a crime scene. The preparation time and formality of risk assessments might vary markedly, but they are of paramount importance in all scientific work.

It is the responsibility of the employer and employee to ensure that the person in the scientific workplace is protected appropriately at all times. Learners should be conversant with health and safety legislation and practices specific to the organisation, and how these legal requirements impact on the work carried out, on a scientific, practical and financial basis.

The principles of using standard procedures should be developed through reference to their use in the world of work, and also to practical activities in the college or school laboratory, and in the field.

Examples in the scientific workplace that require well-defined and international standard procedures include:

- Measurement of the effectiveness of a new antibiotic or other antimicrobial agent
- Measurement of key physiological variables e.g. Heart rate, blood pressure and temperature, by medical staff
- Detection and measurement of drugs, hormones, etc. In blood samples, by biochemical and chemical analysis
- Detection and measurement of poisons in water supplies
- Finding the distribution of organisms in a habitat
- Measuring the effect of pollution on organisms in a habitat

- Scientists testing the properties of new materials under development.

These techniques can all be replicated in a school or college situation (using either an 'industrial' Standard Operating Procedure verbatim or a modified version) and learners should use a range of these techniques, pooling data from different groups where appropriate, comparing results between groups, and appreciating the values of these comparisons.

Learners should appreciate fully the components of a standard procedure and write a range of these, e.g. for a familiar everyday activity or for a new scientific technique. Learners should be given opportunities to use ICT by incorporating visual material into an activity and/or making it interactive. This could include producing a standard procedure/experimental method pictorially or photographically. Other learners could use these to carry out the experiment.

LO2 Know how to use practical techniques in scientific work, in the laboratory and the field, to maintain the quality of the sample and avoid contamination of the laboratory and/or the environment.

The collection, preservation, storage and treatment of samples under investigation, in order to maintain the integrity of the sample and avoid contamination (both to the sample and the environment/working environment), are an essential part of the analytical procedure.

Learners should appreciate that samples need to be collected using an appropriate procedure, avoiding contamination by the operator.

Learners should understand that the proper handling of samples is essential to maintain their integrity/quality, prevent deterioration and prevent contamination. Learners should appreciate the importance of the correct storage prior to analysis. They must be stored in an appropriate, fully-labelled container so they are not subject to contamination, and at a temperature that limits or prevents decay. For the pathologist working in a hospital, the preservation and storage of the sample, so that valid results from the analysis may be obtained, might be a matter of life or death to a patient. If procedures to ensure the integrity of the sample are not followed carefully by the scene of crime officer or forensic scientist, the analysis that follows might lead to wrong conclusions and convictions, or make the evidence inadmissible in court.

As well as during storage, for the analysis itself, learners should understand that to obtain valid results, avoidance of contamination is essential. For the microbiologist working in the pathology lab, or in the food industry, the use of aseptic technique ensures that cultures of microorganisms do not become contaminated. For the analytical chemist, prior to use, glassware must be washed in distilled water, a quantity of the sample under investigation, or a reactant, to ensure that accurate results are obtained.

The learner should also understand that samples must be treated in certain ways so as to avoid contamination of the working and wider environment. The handler does not want to become contaminated either. Correct use of aseptic technique will confine a microorganism to the culture vessel and/or to the experimental container, and used cultures must be disposed of appropriately. Likewise, hazardous chemicals must be prevented from contaminating the working environment and be disposed of according to a defined practice. For the ecologist working in the field, the environment should be returned

to its original state following sampling and testing, and any hazardous analytical chemicals taken back to the laboratory for disposal. The use of suitable contexts, for instance the scene of crimes officer/forensic scientists; an investigator of suspected bacterial contamination of a water supply; a food analyst looking for use of an illegal ingredient in food, e.g. a banned food colourant, will give learners opportunities to practise skills in handling samples and Distinction level learners to articulate these.

Suggested assessment scenarios and guidance on assessment

The following table is for guidance only. It is recommended that centres develop their own assignments relevant to local organisations, resources and contexts.

Criteria	Assignment title	Scenario	Assessment
LO1	Managing risks and hazards	The learner is producing a laboratory manual on the use of practical techniques, for staff in an organisation that uses science.	A section for the laboratory manual, explaining the use of standard procedures in organisations that use science, and the way in which standard procedures are used by laboratories to minimise risks and hazards. The health and safety blog should include sections on definitions of hazards and risks, and health and safety procedures used by organisations, including how hazards are identified, ways of minimising risk, and legislation and other practices used. P1 Learners will identify procedures used by organisations to identify hazards and minimise risk, including an awareness of the statutory regulations placed upon an organisation. M1 Learners will describe these measures in a logical and concise manner, including how they are compliant with the statutory regulations. P2 Learners will outline a specific risk assessment and will indicate which statutory regulations need to be considered. M2 Lists the main components of a standard procedure and describes how these enable the user to work safely based on the

			risk assessment outline in P2.
LO2	Scientific samples	The learner is to produce a report on how the evidence to be used in a legal investigation was collected, stored and handled.	A report on the collection, storage and handling of scientific samples. The report will be used in a legal context. This could be a series of samples collected from a crime scene, a domestic water sample that is suspected to be contaminated, a food sample that may have an illegal ingredient, an environmental sample that may be contaminated, etc. The report will include the methods used to collect, store and handle the samples under investigation. P3 The learner will identify the ways in which the sample in question was collected so as to avoid contamination, stored so that it remained unchanged, and worked with in the laboratory so that it remained uncontaminated. The learner will also identify how the scientist was protected while using the sample. M3 The learner will describe the measures used to maintain the quality of the sample, and avoid contamination, both of the sample and the environment (including the scientist). D1The learner will explain the importance of the techniques used at each stage in the process.