2016 Suite

OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

APPLIED SCIENCE

Unit 2

Laboratory techniques

H/507/6149

Guided learning hours: 90

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LEVEL 3

UNIT 2: Laboratory techniques

H/507/6149

Guided learning hours: 90

Essential resources required for this unit: Well-equipped laboratory with benches suitable for microbiology and a fume cupboard.

This unit is externally assessed by an OCR set and marked examination.

UNIT AIM

The aim of this unit is to provide learners with a good grounding in working in a laboratory. This is a general skills unit and covers generic skills required by technicians working in any kind of scientific laboratory including working for an industrial company, the NHS, contract analysis of environmental samples and working in the education sector. You will learn about the roles and duties of a scientific technician and the systems used to ensure the effective operation of a laboratory. You will understand the importance of health and safety in the laboratory and know how to carry out and record the outcomes of standard laboratory procedures.

TEACHING CONTENT

The teaching content in every unit states what has to be taught to ensure that learners are able to access the highest grades.
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.

For externally assessed units, where the content contains i.e. and e.g. under specific areas of content, the following rules will be adhered to when we set questions for an exam:

- a direct question may be asked about unit content which follows an i.e.
- where unit content is shown as an e.g. a direct question will not be asked about that example.

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
1. Understand the importance of health and safety and quality systems to industry	1.1 To use aspects of good laboratory practice throughout all practicals • the choice of measuring equipment and the importance of calibration	• how to use measuring equipment accurately to reduce the impact of systematic errors • reason for selection of measuring equipment • reason for calibration • how equipment should be calibrated or have its calibration checked, to include: ○ a range of glassware i.e. burettes, measuring cylinders, syringes, bulb and graduated pipettes and volumetric flasks ○ thermometers ○ pH meters ○ balances ○ timers
	• the assessment and management of risk (risk assessments; safety precautions/minimising risk) i.e.:	
	○ following health and safety regulations	• key features of the Management of Health and Safety at work Regulations and COSHH Regulations and their relevance to given examples of scientific and laboratory workplaces

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
		• the main duties of employers and employees under the Health and Safety at Work Act (1974), to include: ○ implementation, if reasonably practicable ○ health and safety applies to all employees ○ safety equipment provided and maintained ○ apply safe protocols in the workplace
	○ recognise laboratory hazards	• hazards can cause harm • examples of typical hazards that may be encountered and apply this in different laboratory scenarios, to include: ○ pathogenic organisms ○ harmful chemicals (including enzymes) ○ blood ○ flammable substances ○ sharp materials (broken glassware, knives, needles, pins) ○ radioactive material ○ spillage and tripping ○ electrical • identify the meaning of the GHS (Globally Harmonised System) Hazard Pictograms ○ 'signal word' (i.e. 'keep out of reach of children', 'warning', 'danger'. 'flammable' and 'harmful') ○ recognise appearance of pictograms (i.e. flame, health hazard, skull and crossbones, exclamation mark, corrosion, gas cylinder, environment and explosion)

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
	○ risk assessment	• steps involved in the process of producing a risk assessment • relevance of the Health and Safety Authority (HSA) for risk assessments • link between specific risks and corresponding hazards, for example but not limited to: ○ infection (pathogenic organisms / blood) ○ poisoning, respiratory damage, burns, (chemicals) ○ fire (flammable substances) ○ contamination (sharp materials) ○ radioactive poisoning, cancer, DNA mutations (radioactive material) ○ contamination, burns, corrosion, physical damage (spillage and tripping)
	○ control measures to minimise risks	• check the labelling on equipment, containers and packages • carry out risk assessments and apply to different scenarios
	• the use of appropriate sampling techniques (the whole sample, representative sample, random sample), labelling and recording samples, storing and transporting samples	• characteristics of whole, representative and random samples • how samples of various types may be stored and transported to ensure that their integrity is not compromised, to include: ○ material used and design of sample container ○ excluding air from certain samples

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
		○ addition of preservatives e.g. use of liquid nitrogen (ie. for DNA samples, embryos, infectious materials); control of gases, including CO_2 ○ temperature control, including refrigeration
	• the recording of procedures used for the collection of high quality data	• identify the most appropriate protocol for data collection • record results in a format to enable traceability to include: ○ designing tables ○ recording appropriate information ○ use of secure IT systems
	• reporting findings in detail and in an appropriate format	• know how to write a full laboratory report • use of typical headings for a laboratory report i.e. title, aim, method, results (including calculations and graphs), discussion and conclusions
	• safe storage of materials ○ in a regulation location ○ clearly identified	• describe the safe storage of materials • consider different storage methods, when applied to different laboratory scenarios • appropriate labelling of stored materials i.e. sample name, date when first stored, maximum storage period, authorising name/signature and safe storage conditions
	• waste disposal	• chemical and biological wastes
	○ standard procedures to be followed for breakages	• reporting • safe cleaning up • disposal using an appropriate container • review cause of breakage • modify protocol, as appropriate

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
	○ standard procedures to be followed for the disposal of both chemical and biological wastes	• safe handling of chemical and biological wastes • disposal of chemical and biological wastes in separate sturdy, leak proof and labelled containers and collection by registered company/organisation
	○ disposal records to be maintained ○ safe disposal of materials	• details of material disposal maintained via secure records • specialist equipment i.e. used syringes, contaminated microscope slides and petri dishes to be sterilised or disposed via (yellow) hazard material waste containers
2. Be able to separate, identify and quantify the amount of substances present in a mixture	2.1 Techniques to separate and identify substances present in a mixture i.e.:	• the main principles of chromatography, to include: ○ chromatography involves the distribution of substances between the mobile phase and the stationary phase ○ the mobile phase carries the components of a mixture to different extents, enabling the components to be separated and identified
	• paper chromatography to separate mixtures of coloured and colourless components e.g. pen dye, plant pigments	• describe how to carry out paper chromatography • interpret the results from a given chromatogram
	• thin-layer chromatography (TLC) to separate mixtures of coloured and colourless components e.g. plant pigments, pharmaceuticals	• describe how to carry out thin-layer chromatography (TLC) to obtain accurate and repeatable results • the advantages of TLC compared to paper chromatography i.e. TLC results are more reproducible, TLC is easier to

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
		use, and separation is more efficient
	• stationary and mobile phases in chromatography	• in paper chromatography the stationary phase is water bound to the paper • in TLC the stationary phase is silica gel • the mobile phase in both types of chromatography is a non-polar solvent or mixture of solvents

	• calculate R_f values and make comparisons (standards, literature values)	• calculate R_f values for spots on given paper chromatograms or TLC chromatograms
		• use of a locating agent, to include:
		  ○ iodine
		  ○ U.V light
		  ○ ninhydrin for amino acids
		• identify an unknown substance by comparison with known substances

	2.2 Alternative qualitative and quantitative techniques offering improved separation and identification, and enhanced accuracy and sensitivity i.e.:	• applications of each technique

	• the use of electrophoresis for the separation of the components of a mixture that are charged in DNA analysis	• explain the principles of the electrophoresis of DNA samples to include:
		  ○ the use of polymerase chain reaction (PCR) to amplify the DNA
		  ○ the application of an electric field causing negatively charged DNA fragments to move towards the positive electrode
		  ○ the use of a gel rather than a solution to improve separation
		  ○ an understanding that shorter fragments move faster because they move more easily through the gel

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
		• interpret the results from gel electrophoresis by comparison with reference data
	• retention times when using gas chromatography (GC) and high performance liquid chromatography (HPLC)	• recognise block diagrams of the equipment used in GC and HPLC • determine the retention times of substances from GC and HPLC chromatograms • identify a substance from its retention time • understand that the relative peak areas are proportional to the amount of each component in the sample
	• producing calibration standards (using serial dilution) to enable quantitative analysis	• describe how to use serial dilution to obtain samples required for a calibration curve. • draw conclusions about the amounts of substances present by reading off a calibration curve
	• positive identification of the components of a mixture when a chromatograph is linked to a mass spectrometer (GC-MS and HPLC-MS)	• outline the principles of MS to include: ○ ionisation ○ fragmentation ○ acceleration ○ deflection ○ detection • interpret spectra in order to identify components • describe the advantages of linking GC and HPLC to a mass spectrometer
3. Be able to determine the concentration of an acid or base using titration	3.1 Techniques to determine the concentration of an acid or base using titration i.e.:	• describe how a titration can be used to determine the concentration of an acid or a base • describe how aspects of good volumetric and titrimetric technique contribute to the accurate determination of concentration, to include: ○ appropriate washing of glassware ○ use of a suitable indicator ○ addition of the titrant dropwise near the endpoint ○ making rough and multiple repeat readings

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
		to obtain concordant results (i.e. readings within 0.1 cm^3) ○ constructing a suitable results table
	• choice of appropriate measuring equipment (burette; one-mark pipette; balance)	• use of equipment of an appropriate precision i.e. ○ 50 cm^3 burette, ○ 10 cm^3 and 25 cm^3 one-mark pipettes (volumetric pipettes), ○ 2 decimal place balance, ○ 100 cm^3 and 250 cm^3 volumetric flasks
	• choice of appropriate indicators i.e. ○ strong acid / strong base, i.e. bromothymol blue ○ strong acid / weak base, i.e. methyl orange ○ weak acid / strong base, i.e. phenolphthalein	• carry out a titration of: ○ a strong acid (e.g. hydrochloric acid) with a strong base (e.g. sodium hydroxide) using bromothymol blue as the indicator. ○ a weak acid (e.g. ethanoic acid) with a strong base (e.g. sodium hydroxide) using phenolphthalein as the indicator ○ a strong acid (e.g. hydrochloric acid) with a weak base (e.g. sodium carbonate) using methyl orange as the indicator
	• calculation of mass required to make a solution of a given concentration	• know that: concentration in g dm^{-3} = concentration in mol dm^{-3} × molar mass • calculate the mass of solute needed to make a solution of a given concentration • describe how to make solutions accurately, to include use of 2 decimal place balance and an appropriate volumetric flask
	• calculation of concentration in mol dm^{-3} given the concentration of one solution	• calculate the mean titre from concordant results. • calculate the number of moles used in the titration using: $n = c \times V$ where c is concentration in mol dm^{-3}, n = number of moles, and V = volume in dm^3

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
		• calculate the unknown concentration in a titration, based on the number of moles needed for equivalence using: c = n/V
	3.2 Alternative techniques offering enhanced accuracy and sensitivity i.e.:	
	• pH meter	• describe how to calibrate a pH meter using appropriate buffer solutions. • describe how to carry out at least one acid base titration using a pH meter • recognise and describe the shape of titration curves for the combinations: ○ strong acid/strong base ○ strong acid/weak base ○ weak acid/strong base • understand that a suitable indicator for a titration should have a pH range within the range of the rapid change in pH at the equivalence point of the titration • use a pH curve to determine the most suitable indicator
	• auto-titration	• know that autotitrators for acid-base titrations use a pH electrode to determine the endpoint • understand that autotitrators are programmed to make small additions of titrant in the region of the endpoint so that a rapid change in pH for a small addition of titrant allows the endpoint to be pinpointed • the advantages and disadvantages of using an autotitrator to determine the concentration of a solution
4. Be able to examine and record features of biological samples	4.1 Techniques to examine and record features of biological samples i.e.:	• biological samples from plants, animals, algae and fungi

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification

	• visual observation (including the use of a hand lens / magnifying glass) - recording the main features, making measurements of distances and lengths, and using reference samples to interpret the image	• advantages and limitations of using a hand/magnifying lens
		• specimen features, to include:
		  ○ colour
		  ○ texture
		  ○ shape
		  ○ size (measuring length and width)
		• use photographs or drawings of reference samples to identify the specimen

	• use of the light microscope, its benefits (observation of living specimens, use of incident light for surface features) and limitations	• features of a light/optical microscope, to include;
		  ○ light source
		  ○ fine and course focus
		  ○ stage/sample table
		  ○ objective and eyepiece lenses
		  ○ stand and base
		• advantages / disadvantages (including limitations) of a light microscope
		• features of light microscope drawings using stained tissues
		• preparation of temporary slides
		• difference between resolution and magnification of light microscopes

	• accurate recording of observations; calculating magnification and scale; use of a graticule	• recording observations using diagrams, photomicrographs or video • use of the equation: magnification = measure size ÷ actual size to calculate magnification of the image, and either the measured or actual size of the specimen • interpretation of the scale • use of an eyepiece graticule and stage micrometre

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
	4.2 Alternative techniques offering enhanced visual examination of microscopic features and features hidden from view or difficult to access i.e.:	
	• electron microscopy gives higher magnification and greater resolution	• advantages and disadvantages of light microscopy and electron microscopy • differences between transmission electron microscopy (TEM) and scanning electron microscopy (SEM) • interpretation of TEM and SEM images
	• X-ray analysis is used to reveal 'hidden' structures, e.g. the skeleton	• basic principles of X-ray radiography • advantages and disadvantages of X-ray radiography
	• ultrasound is used to examine structures that are difficult to access, e.g. pregnancy observations	• basic features of ultrasound scanning, to include: ○ release of soundwave from probe ○ use of gel at probe/surface interface ○ reflection of soundwaves back to probe ○ image generated • advantages and disadvantages of using ultrasound scanning

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
5. Be able to identify cations and anions in samples	5.1 Techniques to identify cations and anions in samples i.e.:	• identify the ions present in an unknown sample from experimental results
	• flame tests for cations: barium, Ba^{2+}; calcium, Ca^{2+}; copper, Cu^{2+} ; lithium, Li^{+}; potassium, K^{+}; sodium, Na^{+}	• describe how to perform a flame test • interpret flame tests and recall flame colours to identify metal ions
	• chemical tests for cations (using precipitation reactions with sodium hydroxide): aluminium, Al^{3+} , copper (II) Cu^{2+} ; iron(II), Fe^{2+}; iron(III), Fe^{3+} ; lead, Pb^{2+}	• tests for cations in aqueous solutions using sodium hydroxide (aq), to include: ○ recall the colour of precipitates and whether they dissolve in excess NaOH(aq)
	• chemical tests for anions: carbonate, CO_3^{2-}, chloride, Cl^{-}, bromide Br^{-}, iodide I^{-} , sulfate, SO_4^{2-}	• tests for anions, to include: ○ addition of dilute acid to test for carbonate ion and use of limewater to identify carbon dioxide. ○ addition of hydrochloric acid to an aqueous solution followed by barium chloride (aq) to test for sulfate ions. ○ addition of nitric acid to an aqueous solution followed by silver nitrate(aq) to test for chloride, bromide and iodide ions
	5.2 Alternative techniques offering improved separation, sensitivity and quantification, to include principles and outline procedures i.e.:	
	• ion chromatography	• outline the technique and basic principles of cationic and anionic exchange chromatography • give some advantages of ion chromatography (IC), to include: ○ high selectivity ○ high sensitivity

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
		○ simultaneous determination of anions and cations ○ small sample size • give some uses of IC, to include: ○ protein purification ○ analysis of amino acids ○ determination of base composition of nucleic acids ○ water purification and analysis ○ quality control
	• atomic emission spectroscopy (AES) and inductively coupled plasma-atomic emission spectroscopy (ICP-AES).	• outline the technique and basic principles of AES • understand that AES is used to identify metal ions in a sample and to determine the concentration of metal ions in solution • understand that each metal ion has a unique spectrum and that the metal present in a sample can be identified by comparison with reference spectra • understand that the concentration of metal in a sample can be found by constructing a calibration curve (emission against concentration) and using the measured emission value to read off the concentration from the graph • understand that solutions used for the calibration curve are made by successive dilution • be aware that AES is limited to alkali metals (Li, Na, K, Rb and Cs) and to Mg and Ca and that ICP-AES is the preferred method for identifying metals because a wide range of metals can be analysed, due to much higher temperatures being used

Learning outcomes The Learner will:	Teaching content Learners must be taught:	Exemplification
		• industrial uses of ICP-AES
6. Be able to use aseptic technique	6.1 The purpose of working in an aseptic or clean room whilst maintaining sterility and cleanliness	• reason for using an aseptic technique • aseptic techniques, to include: ○ sterilisation of equipment ○ decontamination/ sterilisation of working surfaces ○ reducing contamination of sample materials from the environment, including from scientists/technicians • avoiding spread of pathogens/contaminants between specimens and scientists/technicians • organising a laboratory bench to promote aseptic conditions • use of airflow cabinets • examples of laboratory work requiring aseptic techniques, to include: ○ cell and tissue culture ○ preparation of medical test kits ○ pharmaceutical production of drugs/medicines ○ microbiology and surgical procedures
	6.2 To follow standard aseptic procedure to streak a plate, i.e.: • estimation of the purity of a culture e.g. yeast cells, bacteria	• know the technique used to streak a plate interpreting the appearance of streaked plates in terms of the: ○ purity of culture used to streak the plate ○ evidence of contamination
	6.3 To follow standard aseptic procedure in tissue culture (plant tissue, e.g. clone a cauliflower)	• examples and application of tissue cultures • evidence and impact of contamination of tissue cultures • steps involved in the aseptic technique used to create, maintain and duplicate tissue cultures

LEARNING OUTCOME (LO) WEIGHTINGS

Each learning outcome in this unit has been given a percentage weighting. This reflects the size and demand of the content you need to cover and its contribution to the overall understanding of this unit. See table below:

LO1	15-20%
LO2	15-20%
LO3	15-20%
LO4	15-20%
LO5	15-20%
LO6	15-20%

ASSESSMENT GUIDANCE

All Learning Outcomes are assessed through externally set written examination papers, worth a maximum of 90 marks and 2 hours in duration.

Learners should study the basic experimental design requirements, influences and user needs within the taught content in the context of a range of real laboratory experiments. Exam papers for this unit will use examples of real experiments as the focus for some questions, however it is not a requirement of this unit for learners to have any detailed prior knowledge or understanding of particular products used. Questions will provide sufficient product information to be used, applied and interpreted in relation to the taught content. During the external assessment, learners will be expected to demonstrate their understanding through questions that require the skills of analysis and evaluation in particular contexts.

To find out more
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Alternatively, you can email us on **vocational.qualifications@ocr.org.uk**

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