OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

APPLIED SCIENCE

Cambridge TECHNICALS 2016

Unit 2 – Laboratory techniques
DELIVERY GUIDE

Version 2

ocr.org.uk/science

CONTENTS

INTRODUCTION

This Delivery Guide has been developed to provide practitioners with a variety of creative and practical ideas to support the delivery of this qualification. The Guide is a collection of lesson ideas with associated activities, which you may find helpful as you plan your lessons.

OCR has collaborated with current practitioners to ensure that the ideas put forward in this Delivery Guide are practical, realistic and dynamic. The Guide is structured by learning outcome so you can see how each activity helps you cover the requirements of this unit. We appreciate that practitioners are knowledgeable in relation to what works for them and their learners. Therefore, the resources we have produced should not restrict or impact on practitioners' creativity to deliver excellent learning opportunities.

Whether you are an experienced practitioner or new to the sector, we hope you find something in this guide which will help you to deliver excellent learning opportunities.

If you have any feedback on this Delivery Guide or suggestions for other resources you would like OCR to develop, please email resources.feedback@ocr.org.uk.

OPPORTUNITIES FOR ENGLISH AND MATHS SKILLS DEVELOPMENT AND WORK EXPERIENCE

We believe that being able to make good progress in English and maths is essential to learners in both of these contexts and on a range of learning programmes. To help you enable your learners to progress in these subjects, we have signposted opportunities for English and maths skills practice within this resource. We've also identified any potential work experience opportunities within the activities. These suggestions are for guidance only. They are not designed to replace your own subject knowledge and expertise in deciding what is most appropriate for your learners.

English

Maths


Work

Please note

The timings for the suggested activities in this Delivery Guide **DO NOT** relate to the Guided Learning Hours (GLHs) for each unit.

Assessment guidance can be found within the Unit document available from www.ocr.org.uk.

The latest version of this Delivery Guide can be downloaded from the OCR website.

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.

Unit 2 Laboratory techniques	
LO1	Understand the importance of health and safety and quality systems to industry
LO2	Be able to separate, identify and quantify the amount of substances present in a mixture
LO3	Be able to determine the concentration of an acid or base using titration
LO4	Be able to examine and record features of biological samples
LO5	Be able to identify cations and anions in samples
LO6	Be able to use aseptic technique

To find out more about this qualification, go to: http://www.ocr.org.uk/qualifications/vocational-education-and-skills/cambridge-technicals-applied-science-level-3-certificate-extended-certificate-foundation-diploma-diploma-extended-diploma-05847-05849-05879-05874-2016-suite/

RELATED ACTIVITIES

The Suggested Activities in this Delivery Guide listed below have also been related to other Cambridge Technicals in Applied Science units/Learning Outcomes (LOs). This could help with delivery planning and enable learners to cover multiple parts of units.

This unit (Unit 2)	Title of suggested activity	Other units/LOs	
LO1	Preparing for collecting water samples for analysis	Unit 13 Environmental surveying	LO3 Be able to use field and laboratory techniques to conduct environmental investigations LO4 Be able to analyse and present environmental survey findings
	Finding % suspended solids, temperature and pH of a water sample	Unit 2 Laboratory techniques	LO3 Be able to determine the concentration of an acid or base using titration
		Unit 10 Testing consumer products	LO4 Be able to use extraction and separation techniques on consumer products
		Unit 13 Environmental surveying	LO3 Be able to use field and laboratory techniques to conduct environmental investigations LO4 Be able to analyse and present environmental survey findings
	Writing a laboratory report and checking the calibration of timers and thermometers	Unit 13 Environmental surveying	LO3 Be able to use field and laboratory techniques to conduct environmental investigations LO4 Be able to analyse and present environmental survey findings
	Health and safety legislation and laboratory rules	Unit 6 Control of hazards in the laboratory	LO2 Be able to use health and safety procedures to minimise the risk presented by hazards in a laboratory
		Unit 10 Testing consumer products	LO1 Understand the influence of regulatory bodies on development of consumer products
		Unit 17 Food technology	LO2 Understand the importance of food safety in food manufacture
	Checking pipette calibration and preparing questions for technician or visiting rep	Unit 10 Testing consumer products	LO2 Understand how product testing determines the development of consumer products
		Unit 17 Food technology	LO4 Be able to test product samples
	A visit by someone from a local industrial laboratory (or a visit to a local laboratory)	Unit 6 Control of hazards in the laboratory	LO2 Be able to use health and safety procedures to minimise the risk presented by hazards in a laboratory LO3 Be able to design a safe functioning laboratory to manage the risk presented by hazards
	Risk assessment of practical work and common laboratory hazards	Unit 10 Testing consumer products	LO2 Understand how product testing determines the development of consumer products
	Hazard pictograms, density calculations and waste disposal	Unit 10 Testing consumer products	LO1 Understand the influence of regulatory bodies on development of consumer products
		Unit 16 Waste management	LO1 Understand how to manage waste LO3 Understand how waste water is managed
		Unit 17 Food technology	LO2 Understand the importance of food safety in food manufacture LO3 Understand the importance of quality control in food manufacture

This unit (Unit 2)	Title of suggested activity	Other units/LOs	
LO2	Paper chromatography of inks Paper chromatography of plant pigments Thin layer chromatography (TLC) of plant pigment Thin layer chromatography of pharmaceuticals Thin layer chromatography of mixtures of pharmaceuticals High performance liquid chromatography Gas chromatography Visit to see high performance liquid chromatography and gas chromatography in action	Unit 10 Testing consumer products	LO3 Be able to use quantitative titration techniques on consumer products
		Unit 11 Drug development	LO2 Understand the range of techniques used in drug production LO3 Be able to carry out a basic extraction, synthesis, isolation and purification of a simple drug or pharmaceutical
	Electrophoresis (Practical)	Unit 5 Genetics	All LOs
		Unit 8 Cell biology	All LOs
LO3	Simple titration introduced Simple titration practice	Unit 10 Testing consumer products	LO2 Understand how product testing determines the development of consumer products LO3 Be able to use quantitative titration techniques on consumer products
	Calculations related to titrations and making solutions	Unit 3 Analytical techniques	LO1 Be able to use mathematical techniques to analyse data
		Unit 10 Testing consumer products	LO2 Understand how product testing determines the development of consumer products LO3 Be able to use quantitative titration techniques on consumer products
	Making a primary standard solution and using it in a titration to standardise another solution: 1 Making a primary standard solution and using it in a titration to standardise another solution: 2 Use of a pH titration to determine hydrogen carbonate concentration and introduction to autotitrators	Unit 3 Analytical techniques	LO1 Be able to use mathematical techniques to analyse data LO4 Be able to analyse and evaluate the quality of data
		Unit 10 Testing consumer products	LO2 Understand how product testing determines the development of consumer products LO3 Be able to use quantitative titration techniques on consumer products
LO4	Using a hand lens	Unit 18 Microbiology	LO3 Be able to use microbiology in food production
		Unit 19 Crop production and soil science	LO2 Understand factors affecting the growth of crops
	Using a light microscope Preparing a slide – drawing – calculating magnification Use of graticule Haemocytometer Electron microscopes	Unit 8 Cell biology	LO2 Be able to use cytological techniques
	X-ray and ultrasound	Unit 4 Human physiology	All LOs

This unit (Unit 2)	Title of suggested activity	Other units/LOs	
LO5	Flame tests Other cation tests Anion tests	Unit 10 Testing consumer products	LO2 Understand how product testing determines the development of consumer products LO4 Be able to use extraction and separation techniques on consumer products LO5 Be able to test the effectiveness of consumer product tests
	Ion chromatography	Unit 11 Drug development	LO3 Be able to carry out a basic extraction, synthesis, isolation and purification of a simple drug or pharmaceutical
	Flame emission and inductively coupled plasma atomic emission spectroscopy	Unit 3 Analytical techniques	LO1 Be able to use mathematical techniques to analyse data LO2 Be able to use graphical techniques to analyse data
LO6	Cauliflower cloning	Unit 5 Genetics	All LOs
		Unit 8 Cell biology	LO1 Understand the functions of the plasma membrane and endomembrane systems LO2 Be able to use cytological techniques LO3 Understand the cell cycle and the importance of mitosis LO4 Understand the process and significance of differentiation
		Unit 17 Food technology	LO4 Be able to test product samples
	Streaking a plate	Unit 17 Food technology	LO4 Be able to test product samples
		Unit 18 Microbiology	All LOs
	Interpreting the results from cauliflower cloning and streaking a plate	Unit 5 Genetics	All LOs
		Unit 8 Cell biology	LO1 Understand the functions of the plasma membrane and endomembrane systems LO2 Be able to use cytological techniques LO3 Understand the cell cycle and the importance of mitosis LO4 Understand the process and significance of differentiation
	Aspects of aseptic technique/where aseptic technique may be used	Unit 8 Cell biology	LO1 Understand the functions of the plasma membrane and endomembrane systems LO2 Be able to use cytological techniques LO3 Understand the cell cycle and the importance of mitosis LO4 Understand the process and significance of differentiation
		Unit 17 Food technology	LO4 Be able to test product samples
		Unit 18 Microbiology	All LOs

KEY TERMS

Explanations of the key terms used within this unit, in the context of this unit	
Key term	**Explanation**
Analyte	A substance which is being analysed. Its identity (qualitative) or its concentration (quantitative) may be being found in a particular analysis.
Aseptic technique	Methods used to prevent contamination from micro-organisms.
Atomic emission spectroscopy (AES)	Analytical technique based on light emitted from excited outer electrons of atoms as they drop down to the ground state. The atoms may be excited by a flame (as in flame emission spectroscopy/flame tests) or electrically as in inductively coupled plasma atomic emission spectroscopy (ICP-AES).
Autotitrator	Instrument which is programmed to carry out titration automatically.
Calibration	Checking that a piece of equipment is accurate by comparing it to a standard and adjusting it to ensure accuracy. A pH meter may be calibrated because the settings may be altered by the operator to ensure that it gives the correct reading in accurately made buffer solutions of known pH (standards). The calibration of a pipette may be checked by ensuring that it delivers the correct mass of pure water (within the appropriate tolerances) at ambient temperature. Bulb pipettes with one mark may not be adjusted if the pipette is not sufficiently accurate. An automatic pipette may be adjusted.
Chromatography	Analytical separation technique where components of mixture move at different rates in a mobile phase, through a stationary phase.
Cloning	A biological process, producing genetically identical organisms.
Density	Mass per unit volume (density = mass/volume).
Electrophoresis	Analytical separation technique where large molecules (e.g. proteins) move through a buffer medium under the influence of a voltage.
Elution	The process of using a liquid mobile phase to flush an analyte through a stationary phase column in chromatography.
Flame test	Analytical test method used to identify metals in compounds, based on the characteristic colour of light emitted from solutions of the metal compounds in a flame. Energy from the flame excites the outer electron(s) in the free separate metal atoms, produced in the flame to higher energy levels. As the electrons drop from the higher levels back to the ground state, energy, exactly corresponding to the energy differences between levels, is emitted. The wavelengths emitted are very precise. The technique works best for alkali metals and alkali earth metals.
Gas chromatography (GC)	A chromatographic technique where the mobile phase is a gas which moves the components of the analyte mixture through a column. To ensure that the analyte molecules are in the gaseous phase, the column is enclosed in an oven whose temperature may be varied.
Graticule	A network of horizontal and vertical lines at fixed distances. In microscopy (the current context) the term usually refers to an eyepiece graticule – a microscope eyepiece lens which has a disc with lines on it. The eyepiece is calibrated by looking through it at a calibration slide with lines at known distances. The distance between lines on the eyepiece is found. The eyepiece may be used to measure small lengths e.g. the width of a hair. Calibration of the eyepiece graticule must be carried out for each objective lens used.
Haemocytometer	A haemocytometer is a device used to count cells in microscopy. A blood sample is loaded into a special slide with a haemocytometer grid. The design of the slide and the correct loading technique ensure that the volume in the grid is fixed/known. The number of cells in certain sections of the grid is counted (which could involve clicking a counting device as cells are observed in each of the squares). The result is scaled up to work out the concentration of cells in the whole grid and in the solution. If a dye is used, it is possible to identify cells that are alive and cells that are dead.
Hazard	A potential source of harm or adverse health effect on a person/persons e.g. a hotplate is a hazard because it could burn someone and benzene is a hazard because it may cause leukaemia.
Hazard pictogram	A diagram that shows a standard picture used to identify the presence of a particular hazard (e.g. the pictogram showing a flame – for 'flammable').

Explanations of the key terms used within this unit, in the context of this unit	
Key term	**Explanation**
High performance liquid chromatography (HPLC)	A chromatography technique where the mobile phase is a liquid of known composition and is pumped at high pressure through the stationary phase in the column. The composition of the liquid may be kept constant within a run (isocratic elution) or may be varied in a programmed way if the instrument and its software are sufficiently sophisticated (gradient elution). Because there are a huge range of column types and an infinite variety of solvent compositions, the technique has great potential for separating mixtures and quantifying their compositions.
Indicator	A substance which changes colour at the end-point of a titration.
Inductively coupled plasma (ICP)	Inductively coupled plasma (ICP) is a way of exciting atoms so that they emit radiation. The energy comes from electric currents produced by electromagnetic induction. The radiation is then used in atomic emission spectroscopy to identify the presence of elements and to quantify the amount of element in a solution. Because of the high temperatures involved the range of elements that may be excited usefully is much greater than for flame emission, making the technique atomic emission spectroscopy (AES) based on ICP very versatile. An ICP AES instrument is often simply called 'ICP'.
Ion chromatography	A chromatographic technique where the analytes are ions which pass through a column. The basis of the separation depends on ion-exchange principles – the extent to which analyte ions may be attracted to oppositely charged material in the column.
Lawn plate	Lawn plates, also known as spread plates, should result in a heavy, growth of culture spread evenly over the surface of the growth medium e.g. agar plate. This is achieved by placing a few drops of bacterial broth culture in the centre of an agar plate and then using a glass spreader to spread the broth evenly over the surface of the plate. Lawn plates are often used to test the effectiveness of disinfectant solutions or antibiotic discs.
Magnification	In relation to microscopy, magnification measures the extent to which an object viewed under a microscope is magnified. The total magnification is found by multiplying the magnification of the objective lens by the magnification of the eyepiece lens.
Paper chromatography	A type of chromatography where the stationary phase is contained within chromatography paper e.g. water trapped in the fibres of the paper.
pH	Mathematically pH = $-\log_{10}[H^+]$ where $[H^+]$ is the concentration of free hydrogen ions. pH values give a measure of the acidity or alkalinity of a solution. The pH scale ranges from 0–14. A pH of 1 corresponds roughly to a hydrogen ion concentration ($[H^+]$) of 0.1 mol dm^{-3} whereas a pH of 13 corresponds to a hydroxide concentration ($[OH^-]$) of 0.1 mol dm^{-3}. Acidic solutions have pH values in the range 0–6. Alkaline solutions have pH values in the range 8–14.
pH titration	A titration where the end-point is found by using pH measurement.
Primary standard solution	A solution made accurately from a solid primary standard (assumed to be 100% pure, very stable and with a relatively high molecular mass). There are a number of recognised primary standards for different types of analysis (principally titration).
Qualitative analysis	Analysis which provides information about the identity of an analyte.
Quantitative analysis	Analysis which provides information about the amount of an analyte present.
R_f	R_f = distance travelled by a component of a mixture/distance travelled by the solvent front. This term is used in paper chromatography and in thin layer chromatography (TLC). The value may be compared for systems run under exactly the same conditions (e.g. solvent composition, temperature, stationary phase).
Risk	A risk is the likelihood/chance/probability that a person will be harmed or experience an adverse health effect if exposed to a hazard.
Risk assessment	Assessment of the risks associated with an activity and optimisation of the measures put in place to reduce the risk of harm from the hazards. Significant findings are recorded. It is often helpful to complete a pro-forma to ensure a systematic approach.

Explanations of the key terms used within this unit, in the context of this unit	
Key term	**Explanation**
Secondary standard solution	A solution whose concentration has been determined by analysis (usually by titration) involving a primary standard. The substances used as primary standards may not be appropriate for a reaction with the analyte. For example, if the concentration of ethanoic acid (a weak acid) is to be found this is best done by titration against sodium hydroxide (direct titration of the ethanoic acid against the primary standard base, sodium carbonate, may not give a sharp endpoint). Solid sodium hydroxide readily absorbs moisture from the atmosphere and is therefore unsuitable as a primary standard (not pure enough). However the concentration of a sodium hydroxide solution may be found by titration against the primary standard, potassium hydrogen phthalate (KHP). Once its concentration is found, it becomes a secondary standard.
Standard solution	A solution whose concentration is accurately known.
Streak plate	A streak plate involves the progressive dilution of an inoculum of bacteria or yeast over the surface of solidified agar medium in a Petri dish. The result is that some of the colonies on the plate grow well separated from each other. The aim of the procedure is to obtain single isolated pure colonies.
Suspended solids	Tiny solid particles suspended in water as a colloid. The solids may be of organic or inorganic origin. The % suspended solids is used as an indicator of water purity. % suspended solids is a measure of the cloudiness of a water sample.
Thin layer chromatography (TLC)	Branch of chromatography involving a stationary phase (often silica) thinly spread over a plate (often made of plastic). The mixture to be separated is applied with a fine glass tube to a spot which will be above the level of a solvent (mobile phase) which will rise by capillary action through the layer of solid.
Titration	An analytical technique for determining the concentration of a substance in solution by carrying out a reaction with another substance whose concentration is known. A fixed volume of one of the solutions is generally pipetted into a conical flask. The other solution is added to the pipetted solution from a burette until the endpoint (often determined by using an indicator) is reached. Knowing the volume used for both solutions and the concentration of one of the solutions, the concentration of the other solution may be calculated.

MISCONCEPTIONS

Some common misconceptions and guidance on how they could be overcome		
What is the misconception?	**How can this be overcome?**	**Resources which could help**
Learners are often confused by the difference between hazard and risk	Tutor should present appropriate contexts, for which learners may identify hazard and risk.	http://www.hse.gov.uk/risk/faq.htm https://worksmart.org.uk/health-advice/health-and-safety/hazards-and-risks/what-difference-between-hazard-and-risk
It is difficult for learners to understand analytical practice in a working laboratory, including use of standard documentation, booking in and labelling of samples	Arrange visits to working laboratories and invite speakers to talk about laboratories.	http://www.abpischools.org.uk/page/modules/labpilotplant/index.cfm http://www.slideshare.net/sunandobasu10/good-laboratory-practice-documentation http://www.who.int/ihr/training/laboratory_quality/documents/en/
When calculating the R_f value of a spot in chromatography, learners need to identify the centre of the spot	Tutor could show learners examples of chromatograms and demonstrate how R_f would be calculated.	http://courses.chem.psu.edu/chem36/Experiments/PDF's_for_techniques/TLC.pdf
Learners often assume that using instrumentation makes analysis more accurate	Tutor could show learners results from an autotitrator, set up with various issues – e.g. lack of calibration, volumes to be added too large.	http://chemwiki.ucdavis.edu/Analytical_Chemistry/Data_Analysis/Instrument_Calibration_over_a_regime http://faculty.atu.edu/abhuiyan/Course/Chem%204414/Chapter%201.ppt
Learners often find it difficult to set up a microscope	Tutor and/or support workers should check whether learners have understood how to set up their microscope and focus with lenses of various magnification.	http://www2.mrc-lmb.cam.ac.uk/microscopes4schools/microscopes2.php http://www.amazon.co.uk/Basic-Bioscience-Laboratory-Techniques-Pocket/dp/0470743093 http://www.amazon.co.uk/Essential-Laboratory-Skills-Biosciences-Wiley/dp/0470686472/ref=sr_1_1?s=books&ie=UTF8&qid=1440342079&sr=1-1&keywords=essential+laboratory+skills+for+the+biosciences

SUGGESTED ACTIVITIES

LO No:	1		
LO Title:	**Understand the importance of health and safety and quality systems to industry**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Preparing for collecting water samples for analysis  See Lesson Element Preparing for collecting water samples for analysis	Tutors could introduce standard methods by presenting a method for finding % suspended solids in a water sample. Tutors could demonstrate checking the calibration of a balance and the use of standard documentation. Useful resources: http://www.who.int/ihr/training/laboratory_quality/documents/en/ http://www.slideshare.net/sunandobasu10/good-laboratory-practice-documentation Learners could prepare filter paper for weighing (washing and placing it in an oven). Learners could use computers to research representative sampling, sample containers, labelling of samples and information that could be recorded and could check calibration of a balance. Tutors could present best practice information about sampling, sample containers and labelling samples. Tutors could lead a discussion about planning a sampling trip, discussing what to take and the likely hazards and how that risk will be minimised. Learners could risk assess a trip to sample water from a local river or pond and weigh their filter papers.	2 hours	Unit 13 LO3, LO4
Finding % suspended solids, temperature and pH of a water sample 	Learners could measure the temperature of the water samples, filter the 100 cm^3 volume of shaken sample, and place the filter paper in the oven. (Learners need not collect the samples themselves but it enhances their experience if this can be arranged.) Tutors could demonstrate checking the calibration of a 100 cm^3 measuring cylinder (used in measuring % suspended solids). Tutor could explain how to complete a laboratory notebook and the procedures used in relation to documentation to ensure traceability in industry. Tutors could demonstrate calibration of a pH meter and measurement of pH. Learners could calibrate their pH meters, measure the pH, reweigh the dried filter paper and determine % suspended solids in water samples, recording details in their laboratory notebooks.	2 hours	Unit 2 LO3 Unit 10 LO4 Unit 13 LO3, LO4

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Writing a laboratory report and checking the calibration of timers and thermometers	Tutors could explain how to write a laboratory report. Learners could write a report on the measurement of temperature, pH, % suspended solids in water samples. Tutors could demonstrate checking the calibration of timers and thermometers and recording findings. Useful resource: https://www.youtube.com/watch?v=VpJULQlCiGM Learners could check the calibration of timers and thermometers and record their findings.	2 hours	Unit 13 LO3, LO4
Health and safety legislation and laboratory rules	Tutors could explain the terms primary and secondary legislation, approved codes of practice and guidance with particular reference to health and safety legislation. Learners could use the Health and Safety Executive (HSE) website and complete a worksheet about health and safety legislation relevant to scientific workplaces. Groups of learners could deliver a short presentation about a given piece of legislation to other members of the group. Useful resource: http://www.hse.gov.uk/ Learners could explain how the centre's laboratory rules are related to health and safety legislation.	2 hours	Unit 6 LO2 Unit 10 LO1 Unit 17 LO2
Checking pipette calibration and preparing questions for technician or visiting rep 	Tutors could demonstrate how to use a pipette correctly. Learners could check the calibration of a pipette by weighing the amount of water it delivers, calculating the volume (volume = mass/density) delivered from the accurate density of water at the ambient temperature and checking that it is within the acceptable limits. Learners could use computers to access a virtual tour of an industrial laboratory and complete a worksheet devised by their tutor. Useful resource: http://www.abpischools.org.uk/page/modules/labpilotplant/index.cfm Learners could plan questions that they would ask a visiting speaker from a local industrial laboratory in relation to health and safety, quality systems, documentation and calibration.	2 hours	Unit 10 LO2 Unit 17 LO4

Title of suggested activity	Suggested activities	Suggested timings	Also related to
A visit by someone from a local industrial laboratory (or a visit to a local laboratory) 	A visiting speaker (or visit host) could describe what their laboratory does. Learners could ask the visiting speaker (or visit host) questions about health and safety, quality systems, documentation and calibration and record answers. Learners could make notes on the systems in place in the industrial laboratory.	2 hours	Unit 6 LO2, LO3
Risk assessment of practical work and common laboratory hazards	Tutors could introduce a procedure for assessing the risk associated with a practical activity and introduce the sources of information. Learners could carry out a risk assessment for measuring the pH of a given range of solutions. A centre laboratory technician could describe how chemicals are stored and moved safely. Tutors could issue information on hazard pictograms and other safety signage so that learners may familiarise themselves. Learners could use the following website which gives a description of best practice in laboratories: http://www.astm.org/SNEWS/ND_2010/zimmerman_nd10.html Learners could use the CLEAPPS website which gives access to practical resources and safety information and guidance: www.cleapss.org.uk	2 hours	Unit 10 LO2
Hazard pictograms, density calculations and waste disposal	Learners could do a quiz about hazard pictograms. Tutors could initiate revision of volumetric calibration by demonstrating how to use the density = mass/volume equation to check whether a piece of equipment measures volume within an acceptable tolerance. Learners could carry out calculations on this topic. Tutors could invite a technician to provide information about disposal of chemical and biological waste.	2 hours	Unit 10 LO1 Unit 16 LO1, LO3 Unit 17 LO2, LO3

SUGGESTED ACTIVITIES

LO No:	2		
LO Title:	**Be able to separate, identify and quantify the amount of substances present in a mixture**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Paper chromatography of inks	Learners could follow a simple given method to separate the colours in ink from felt pens on paper using water as a solvent. Tutors could introduce more sophisticated methodology and terminology (e.g. spotting tube, solvent, solvent front, mobile phase, stationary phase, chromatography tank, R_f value). Learners could use a spotting tube with vials of black ink. Learners could use different solvent mixtures and comment on how effective the separation is in terms of the separation of spots. Learners could comment on the relative affinity for the mobile and stationary phases of the different components of the mixture. Useful resources: http://infohost.nmt.edu/~jaltig/TLC.pdf http://courses.chem.psu.edu/chem36/Experiments/PDF's_for_techniques/TLC.pdf Learners may find the following textbooks useful: Bonner, P.L.R. and Hargreaves, A.J. (2011) *Basic Bioscience Laboratory Techniques: A Pocket Guide*. Wiley-Blackwell Provides information on cell culture, chromatography, microscopy, weighing and making up solutions. Has links to other sources of information. Meah, M. and Kebede-Westhead, E. (2012) *Essential Laboratory Skills for Biosciences*. Wiley-Blackwell Provides information on aseptic technique, microscopes, titration, making up solutions and chromatography.	2 hours	Unit 10 LO3 Unit 11 LO2, LO3
Paper chromatography of plant pigments	Learners could grind green leaves or dried herbs with propanone and sand in order to extract the pigments, before filtering and concentrating the extract. Learners could commence running a paper chromatogram of the pigments in a similar way to running the chromatogram of the ink. Tutors could explain the calculation of the R_f value and lead a discussion about the quality of the separation of the pigments. Learners could calculate the R_f value of particular spots on the chromatogram and comment on the separation.	2 hours	Unit 10 LO3 Unit 11 LO2, LO3

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Thin layer chromatography (TLC) of plant pigment	Tutors could introduce thin layer chromatography (TLC). Useful resources: http://www.rsc.org/learn-chemistry/resource/res00001074/thin-layer-chromatography http://infohost.nmt.edu/~jaltig/TLC.pdf http://courses.chem.psu.edu/chem36/Experiments/PDF's_for_techniques/TLC.pdf Learners could carry out TLC on pigments extracted from leaves and could research other types of chromatography while waiting for the chromatogram to run. Tutors could lead a discussion, comparing TLC with paper chromatography. Tutor could encourage learners to explain the principles behind the separation in terms of the relative affinity of the components of the mixture for the stationary and mobile phases. Learners could calculate some R_f values, discuss the quality of their results and explain their results, considering the polarity of the components, stationary and mobile phases and the size of the components' molecules.	2 hours	Unit 10 LO3 Unit 11 LO2, LO3
Thin layer chromatography of pharmaceuticals See Lesson Element TLC of pharmaceuticals	Learners could follow a given method to carry out TLC on solutions of pure pharmaceutical compounds (e.g. aspirin, paracetamol, ibuprofen, caffeine). Learners should visualise the spots using ultraviolet light and/or iodine (in an iodine tank). Since problems sometimes arise if the concentration of pharmaceutical compounds is not optimised or the solvent mixture is inappropriate, learners could repeat the procedure, modifying their method in order to get discrete spots for the pharmaceutical compounds, above the baseline and below the solvent front. Learners could calculate the R_f values of the compounds and compare their results.	2 hours	Unit 10 LO3 Unit 11 LO2, LO3
Thin layer chromatography of mixtures of pharmaceuticals See Lesson Element TLC of pharmaceuticals	Learners could carry out TLC on pure pharmaceutical compounds and on a given mixture, order to determine the components of the mixture. Learners could repeat the procedure to improve their results. Tutors could introduce high performance liquid chromatography (HPLC) as an alternative chromatographic procedure for separating such mixtures and describe its use in industry.	2 hours	Unit 10 LO3 Unit 11 LO2, LO3

Title of suggested activity	Suggested activities	Suggested timings	Also related to
High performance liquid chromatography	Learners could use textbooks and websites in order to investigate the equipment used in high performance liquid chromatography (HPLC), guided by a worksheet produced by the tutor. Learners could answer questions and draw a block diagram of the instrumentation. Tutors could explain how HPLC is used qualitatively and quantitatively, using examples from a worksheet. Learners could complete the worksheet to consolidate their understanding.	2 hours	Unit 10 LO3 Unit 11 LO2, LO3
Gas chromatography	Learners could use textbooks and websites in order to investigate the equipment used in gas chromatography (GC), guided by a worksheet produced by the tutor. Learners could answer questions and draw a block diagram of the instrumentation. Tutors could explain how GC is used qualitatively and quantitatively, using examples from a worksheet. Learners could complete the worksheet to consolidate their understanding.	2 hours	Unit 10 LO3 Unit 11 LO2, LO3
Visit to see high performance liquid chromatography and gas chromatography in action	Learners could visit an industrial laboratory or a university to see HPLC and GC in action as stand-alone techniques and coupled with mass spectroscopy. (Alternatively, learners could watch video clips of the instrumentation and analyse information from websites, identified by the tutor.)	2 hours	Unit 10 LO3 Unit 11 LO2, LO3
Electrophoresis (Theory)	Tutors could explain how polymerase chain reaction (PCR) magnifies DNA and how the DNA is run on a gel by the technique of electrophoresis and learners could answer questions on a worksheet throughout the explanation. Learners could watch appropriate short video clips, selected by their tutor, making notes on a worksheet prepared by the tutor to consolidate understanding. Learners could make a poster to demonstrate their understanding. Learners may find the following textbook useful: Lundanes, E., Reubsaet, L. and Greibrokk, T. (2013) *Chromatography: Basic Principles, Sample Preparations and Related Methods*. Wiley VCH Has chapters on HPLC, GC and electrophoresis.	2 hours	
Electrophoresis (Practical)	Learners could carry out parts or all of the practical techniques involved in electrophoresis of magnified DNA. Tutor could ensure that a presentation of the stages is available for the learners' revision.	2 hours	Unit 5 All LOs Unit 8 All LOs

SUGGESTED ACTIVITIES

LO No:	3		
LO Title:	**Be able to determine the concentration of an acid or base using titration**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Simple titration introduced	Tutors could demonstrate a simple titration procedure e.g. titration of 0.1 mol dm^{-3} HCl with 0.1 mol dm^{-3} NaOH. Learners could carry out the titration and calculate the concentration of the acid, given the accurate concentration of the alkali. Learners may find the following website useful as it covers the basics of titration in a handbook which introduces use of autotitrators: http://uk.mt.com/gb/en/home/supportive_content/know_how/Dummy_Basics_of_Titration_Handbook.html	2 hours	Unit 10 LO2, LO3
Simple titration practice	Learners could carry out a weak acid/strong alkali titration and a strong acid/weak alkali titration using suitable indicators. Useful resource: http://www.chemguide.co.uk/physical/acidbaseqiamenu.html#top Learners may find the following website useful as it has videos showing aspects of technique relating to making solutions, pipettes, pH materials, electrophoresis of DNA, microbiology and cell culture: http://www.bio-rad.com/en-uk/education/support/tutorials	2 hours	Unit 10 LO2, LO3
Calculations related to titrations and making solutions 	Tutors could demonstrate use of the c = n/V equation and learners could make notes. Learners could perform calculations, based on titrations, using the c = n/V equation. Tutors could demonstrate use of the $n = m/M_r$ equation in conjunction with the c = n/V equation in order to work out how much solid is required to make a solution of a given volume of a given concentration and learners could make notes. Learners could perform calculations from a differentiated worksheet based on the $n = m/M_r$ equation in conjunction with the c = n/V equation.	2 hours	Unit 3 LO1 Unit 10 LO2, LO3

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Making a primary standard solution and using it in a titration to standardise another solution: 1	Learners could calculate the amount of potassium hydrogen phthalate (KHP) (primary standard) needed to make a given amount of a 0.1 mol dm^{-3} solution and then make the solution and use it in a titration to determine the accurate concentration of an approximately 0.1 mol dm^{-3} NaOH solution. Tutors could lead a discussion on the sources of error, based on comparison of the learners' results.	2 hours	Unit 3 LO1, LO4 Unit 10 LO2, LO3
Making a primary standard solution and using it in a titration to standardise another solution: 2	Learners could calculate the amount of anhydrous sodium carbonate (primary standard) needed to make a given amount of a 0.1 mol dm^{-3} solution and then make the solution and use it in a titration to determine the accurate concentration of an approximately 0.1 mol dm^{-3} HCl solution. Tutors could lead a discussion on the sources of error, based on a comparison of the learners' results.	2 hours	Unit 3 LO1, LO4 Unit 10 LO2, LO3
Use of a pH titration to determine hydrogen carbonate concentration and introduction to autotitrators See Lesson Element 3 Use of a pH titration to determine hydrogen carbonate concentration and introduction to autotitrators	Tutors could demonstrate how to set up equipment to carry out a pH titration. Learners could carry out a pH titration of bottled water with 0.01 mol dm^{-3} HCl adding 0.5 cm^3 at a time. Learners could use Microsoft Excel to plot graphs of pH versus volume of HCl added and DpH/Dvolume versus volume of HCl added in order to find the endpoint of the titration and the amount of hydrogen carbonate present in the bottled water. (Tutor could demonstrate how to set up an appropriate spreadsheet.) Tutor could provide a worksheet outlining how autotitrators work and asking questions about use of an autotitrator based on the pH titration carried out by the learners. Learners could watch video clips on use of autotitrators. For example: https://www.youtube.com/watch?v=OcvZ_2kFkGM https://www.youtube.com/watch?v=sdqAzFTGuFY If the centre has an autotitrator, the tutor could demonstrate its use.	4 hours	Unit 3 LO1, LO4 Unit 10 LO2, LO3

SUGGESTED ACTIVITIES

LO No:	4		
LO Title:	**Be able to examine and record features of biological samples**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Using a hand lens	Tutors could explain how to compare fingerprint detail in order to find a match, using a hand lens. Learners could use a hand lens to find a fingerprint match. Tutors could explain how to use a hand lens to identify objects of interest e.g. insects, wheat, seeds or wheat grains using standard reference samples and a scale. Learners could use a hand lens to identify objects of interest as instructed.	2 hours	Unit 18 LO3 Unit 19 LO2
Using a light microscope	Tutor could explain how to set up and use a light microscope while learners could follow the explanation whilst setting up their own microscopes. Learners could use a light microscope to look at prepared tissue slides and make scale drawings. Tutor could draw learners' attention to important issues throughout this activity. Learners could identify the components of a light microscope as a quiz activity.	2 hours	Unit 8 LO2
Preparing a slide – drawing – calculating magnification	Learners could prepare a slide of an onion skin. Learners could scale drawings of their prepared slide under different magnifications and calculate total magnification.	2 hours	Unit 8 LO2
Use of graticule	Tutors could explain how a graticule is used. Learners could prepare a slide of a human hair. They could calibrate a graticule eyepiece with a calibration slide and then calculate the width of the hair under different magnifications. Learners could compare their results.	2 hours	Unit 8 LO2
Haemocytometer	Tutors could explain how to use a haemocytometer. Learners could use a haemocytometer to work out the number of cells per cm^3.	2 hours	Unit 8 LO2

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Electron microscopes	Tutors could explain the operation of the transmission electron microscope and the scanning electron microscope, directing learners to useful sources of information, while learners could complete a worksheet to consolidate understanding. Learners could make a poster to explain the operation of the two types of electron microscope and the information that may be obtained from them. Learners could make a comparison between the light microscope and the transmission electron microscope. Useful resources: http://www.ivyroses.com/ https://www.jic.ac.uk/microscopy/intro_EM.html	2 hours	Unit 8 LO2
X-ray and ultrasound	Tutors could explain how different types of X-ray technique and ultrasound are used in medicine to produce diagnostic images, while learners could complete a worksheet to consolidate understanding. Learners could identify the sources of different images and explain the sorts of information that is likely to be obtained from these images. Useful resources: http://www.genesis.net.au/~ajs/projects/medical_physics/index.html http://www.iop.org/education/teacher/resources/teaching-medical-physics/page_54690.html	2 hours	Unit 4 All LOs

SUGGESTED ACTIVITIES

LO No:	5		
LO Title:	**Be able to identify cations and anions in samples**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Flame tests	Tutors could demonstrate how to carry out a flame test. Learners could carry out flame tests on cations whose identity is known before using the technique to identify an unknown cation. Tutors could lead a discussion, comparing results.	2 hours	Unit 10 LO2, LO4, LO5
Other cation tests	Tutors could explain how to carry out test tube reactions to identify cations, e.g. explaining how to add reagents dropwise and in excess. Learners could use a flow chart to identify cations from test tube reactions. Learners could use given descriptions of test tube analysis to identify unknown cations, using the flow chart.	2 hours	Unit 10 LO2, LO4, LO5
Anion tests	Tutors could explain how to identify chloride, bromide, iodide, sulphate and carbonate. Learners could carry out test tube identification reactions on anions whose identity is known before identifying unknown anions. Tutors could lead a discussion, comparing results and discussing problems. Learners may find the following website useful as it shows classic chemistry experiments including testing salts for anions and cations and experimental sheets for testing for anions and cations: http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/534/cce-80.pdf	2 hours	Unit 10 LO2, LO4, LO5

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Ion chromatography	If possible, learners could visit an industrial or higher education laboratory to see an ion chromatograph in operation and learners could complete a worksheet to consolidate learning. Alternatively, tutors could describe the component parts of an ion chromatograph and explain how it works and learners could complete a worksheet to consolidate learning. Useful resource: http://serc.carleton.edu/microbelife/research_methods/biogeochemical/ic.html Learners could interpret data from an ion chromatograph and prepare a poster or PowerPoint presentation on the technique.	2 hours	Unit 11 LO3
Flame emission and inductively coupled plasma atomic emission spectroscopy 	Tutors could explain how a simple gas flame emission instrument works, explaining the component parts. Tutors should explain the units often used for concentration mg dm^{-3} or parts per million (ppm). Learners could complete a worksheet to consolidate learning. Given appropriate data, learners could construct a calibration plot for potassium and then determine the amount of potassium in a water sample. Learners could perform calculations on unit conversions from a differentiated worksheet. Learners could research the technique of inductively coupled plasma atomic emission spectroscopy (ICP-AES), using guidance from questions in a worksheet and websites or books, recommended by their tutor, to ensure a focused approach.	2 hours	Unit 3 LO1, LO2

SUGGESTED ACTIVITIES

LO No:	6		
LO Title:	**Be able to use aseptic technique**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Cauliflower cloning	Tutors could introduce aseptic technique briefly and then demonstrate how it is used to clone cauliflower. Learners should use aseptic technique when setting up a cauliflower cloning experiment. Useful resource: http://www.saps.org.uk/secondary/teaching-resources/706-cauliflower-cloning-tissue-culture-and-micropropagation	2 hours	Unit 5 All LOs Unit 8 LO1, LO2, LO3, LO4 Unit 17 LO4
Streaking a plate	Tutors could demonstrate how to produce a streak plate and explain why it may be used, highlighting aspects of aseptic technique. Learners could complete a worksheet to consolidate learning. Learners could prepare a streak plate which will be incubated at a suitable time so that results will be visible at the next session. http://www.nuffieldfoundation.org/practical-biology/standard-techniques	2 hours	Unit 17 LO4 Unit 18 All LOs
Interpreting the results from cauliflower cloning and streaking a plate	Learners could discuss and record observations from their own cauliflower cloning and streak plate experiments. Tutors should ensure that learners' observations are appropriate. Learners could repeat the streaking of a plate and/or cauliflower cloning in order to become more proficient.	2 hours	Unit 5 All LOs Unit 8 LO1, LO2, LO3, LO4
Aspects of aseptic technique/ where aseptic technique may be used 	Using resources (websites or books) identified by the tutor, learners could research aspects of aseptic technique, disinfection and sterilisation and where aseptic technique is used in industry or in research. Learners could prepare a leaflet, giving guidance on aspects of aseptic technique and showing how aseptic technique is useful. Learners and tutors may find the following website useful as it has resources on microbiology experiments and activities, prepared by the Microbiology Society: http://www.microbiologyonline.org.uk/teachers	2 hours	Unit 8 LO1, LO2, LO3, LO4 Unit 17 LO4 Unit 18 All LOs

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