Cambridge NATIONALS

Accredited

Science in the Workplace

Level 1/2

UNIT R074 - How scientists use analytical techniques to collect data

UNIT R075 - How scientific data is used

DELIVERY GUIDE

VERSION 1 JULY 2013

OCR

CONTENTS

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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 objective so you can see how each activity helps you cover the specification.

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 resourcesfeedback@ocr.org.uk.

PLEASE NOTE

The activities suggested in this Delivery Guide MUST NOT be used for assessment purposes. (This includes the Consolidation suggested activities).

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.

OPPORTUNITIES FOR ENGLISH AND MATHS SKILLS DEVELOPMENT

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. 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.

KEY

English

Maths

UNIT R074 - HOW SCIENTISTS USE ANALYTICAL TECHNIQUES TO COLLECT DATA

Guided learning hours : 30

PURPOSE OF THE UNIT

The focus of learning for LO1 should be on good laboratory practice. Learners will be taught that scientists select procedures that will enable them to collect valid data, i.e. procedures that will enable the scientist to measure what they truly set out to measure. Learners will need to understand that the equipment and techniques selected by scientists must also enable them to collect data of an appropriate accuracy and precision. The learner should appreciate that instruments that measure with high accuracy and precision may also need calibration before use.

Learners will develop an understanding of the importance (and legality) of working safely in the laboratory, field or scientific workplace, and should develop the skills required to construct, use and review risk assessments.

Within LO1, learners should be introduced to sampling techniques, and the idea of collecting and analysing a whole sample, representative samples or random samples. Learners will be taught how to collate and summarise the results of the analyses carried out on such samples. Learners will be taught how to assess the quality and limitations of their data, which should lead to discussions about repeatability and reproducibility, and how uncertainty can arise from random and systematic error. The focus of learning for LO2 is on the techniques that can be used to separate and identify substances in a mixture. Learners should be taught about chromatography. They should be provided with opportunities to carry out chromatographic techniques e.g. paper or thin layer chromatography. When carrying out these techniques learners should develop an understanding of the terms stationary phase and mobile phase in chromatography and be able to calculate Rf values. Learners should be taught that scientists use a number of alternative techniques that improve the separation of mixtures and have far greater sensitivity. These techniques should include gas chromatography (GC), High-Performance Liquid Chromatography (HPLC) and electrophoresis. Learners should be taught the principles of these techniques and their limitations.

In LO3, learners should be taught about the techniques that can be used to examine and record the features of samples, such as using visual and microscopical examination of fingerprints, fibres or hair. Learners should develop an understanding of the importance of recording observations accurately, how to take measurements, and how to calculate magnification and scale. Learners should understand the limitations of these techniques (magnification, resolution and imperfect evidence or structures hidden from view). Learners should also be taught about the use of electron microscopy, and physical techniques, such as x-rays and ultrasound analysis, as alternatives to light microscopy.

Techniques that can be used to identify cations and anions in samples are the focus in LO4. Learners should be provided with opportunities to carry out a series of flame tests and chemical tests that can be used to identify ions and analyse unknowns. Learners should develop skills that enable them to discuss the limitations of these tests. Within this LO learners should be introduced to alternative techniques that can improve the separation and identification of cations and anions in samples, for example ion chromatography, atomic emission spectroscopy (AES), and inductively coupled plasma-atomic emission spectroscopy (ICP-AES).

In LO5, learners will use acid-base titrations to determine the concentration of acids or bases/alkalis. Learners should be taught how to use equipment of an appropriate accuracy and precision, such as burettes and one-mark pipettes, to measure volumes of solutions. Learners will be taught how to choose appropriate indicators for particular titrations. They will be taught how to use calculations to determine the concentration of an acid or alkali.

The focus of learning for LO6 is the determination of the concentration of coloured substances in solution. For some learners, this will involve visual comparison with a series of standards that learners have made up. Learners will be introduced to the technique and principles of colorimetry. Learners should recognise the use of transmission and absorbance scales of the colorimeter, and be able to make decisions about the filter to use depending on the colour of the sample to be analysed. Learners should collect data and draw calibration curves using appropriate lines of best fit, then use these to determine the concentration of substances, e.g. a dye, in solution. Learners will make comparisons between the colorimetric procedure they have used, using individual filters, with the use of a single beam spectrophotometer, in which the absorbance of a sample can be measured at a specific wavelength, most often from the uv-visible range.

LO2-5 requires candidates to be introduced to alternative analytical techniques. Candidates are not expected to have a detailed understanding of how these techniques work; the focus of learning should be on the benefits of the alternative techniques, related to the quality of data these techniques can provide.

Learning Outcome - The learner will:
1 Be able to apply the principles of good laboratory practice
2 Be able to separate and identify the substances present in a mixture
3 Be able to examine and record features of samples
4 Be able to identify cations and anions in samples
5 Be able to determine the concentration of an acid or base using titration
6 Be able to determine the concentration of coloured substances in solution

LEARNING OUTCOME 1 - BE ABLE TO APPLY THE PRINCIPLES OF GOOD LABORATORY PRACTICE

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Introducing risk assessment 	Learners could access the 'Five steps to risk assessment' leaflet from the following web link: www.hse.gov.uk/pubns/indg163.pdf Using the information contained in the leaflet, learners could produce an information source explaining how the assessment and management of risks is carried out. Learners must cover all relevant points such as: - What is a risk assessment? - Why must risk assessments be carried out? - What is a hazard? - What is a risk? - List and explain the five steps in a risk assessment? - Where could someone get further information? This work could be presented in a number of ways to suit the learning style of the individual learner, for example poster, fact sheet, film a short advert, a letter addressed to someone who wrote to them asking for information and advice on risk assessment and management. This activity is detailed in OCR's Lesson Element 'Introducing Risk Assessment'.	1 hour	R075: LO4
2 Practical risk assessment 	Learners could start by carrying out a risk assessment for making a cup of tea. Discuss this with the class before asking learners to carry out a risk assessment for a number of laboratory procedures, for example carrying out chromatography to separate the pigments in a leaf or the colours in ink, the use of a light/electron microscope to observe a specimen, carrying out a flame test to identify anions/cations, carrying out a titration, the use of a colorimeter to test the concentration of coloured substances in a solution. This could be carried out as an individual task or linked to the practical work within this unit. Learners could present their work in a table with the following headings: The hazard, The risk, The risk level, The control, First aid.	30 minutes to 1 hour 30 minutes depending on the number of procedures assessed	R074: LO2, LO3, LO4, LO5, LO6 R075: LO4

Suggested content	Suggested Activities	Suggested timings	Links to other units
3 Know the hazards 	Learners could be asked to look up and record the hazard symbols for the following words: - explosive, - oxidising, - flammable, - toxic, - harmful, - corrosive, - irritant, - dangerous for the environment. The information could be recorded in a table with the following headings: Symbols, Meaning and Description/ Explanation. The table could be presented as a fact/ information sheet or a poster, or could be produced as a card sort activity. Example bottles of chemicals could be available as a visual stimulus. Learners could also write a list of 'do' and 'don't' that should be followed when using a chemical with each different hazard sign on. If learners are on work placements they could do a survey on the types of hazard symbols they see in the work place, what they mean and why are they there.	30 minutes–1 hour	R075: LO4
4 Know the rules 	Learners could discuss and produce a set of rules that laboratory users must follow with explanations as to why they must be followed. This could be made into a class contract that all members of the class agree to follow and understand why they must follow each rule.	30 minutes	
5 Managing risk: starter for 10 	Learners could test their knowledge about Risk Assessments by completing section 11.6 Managing Risk on the Starter for 10 worksheet available at the following webpage: www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/415/RSC%20Starter%20for%20Ten%20-%2011.%20Experimental%20Skills.pdf?v=1364058866623 Answers are available at the end of the worksheet.	30 minutes	
6 The choice of measuring equipment and the importance of calibration 	Learners could carry out the following activity and then discuss which piece of measuring equipment for each task was more accurate and precise and why. Learners could: - measure out 10ml of a solution using a pipette, a 10ml measuring cylinder, a 25ml measuring cylinder, a 50 ml measuring cylinder, a 25 ml beaker, a 50 ml beaker, a 100 ml beaker and a 250ml beaker - weigh out 125g of a substance using bathroom scales, kitchen scales, a 1dp balance and a 2dp balance - measure out 125cm along the ground using a trundle wheel, a meter stick, a 50cm ruler, a 30cm ruler and a 15cm ruler. - use a range of thermometers to take the temperature of a solution.	30 minutes	R074: LO5

Suggested content	Suggested Activities	Suggested timings	Links to other units
7 Equipment: starter for 10 	Learners could test their knowledge on equipment by completing section 11.1 Equipment on the Starter for 10 worksheet available at the following webpage: www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/415/RSC%20Starter%20for%20Ten%20-%2011.%20Experimental%20Skills.pdf?v=1364058866623 Answers are available at the end of the worksheet.	30 minutes	R074: LO5
8 Getting the 'write' instructions 	Learners could write directions for another learner to get from point A in the school to point B. The destination must be specific, eg the corner of a particular room, or sitting on the third chair back on the right side of a particular room. The first learner writes the directions to get from A to B. The second learner must then follow the directions/instructions to get to the destination (without knowing the destination). The second learner then needs to report back and say where they think the destination was. (This activity could be altered slightly to have one learner directing a blindfolded learner around a room without hitting any furniture.) Risk assessments and careful supervision are required for this activity. The learners could then discuss how successful the directions were, what would need to be done to make them easier to follow and get to the final destination more accurately. Learners should appreciate how specific they need to be eg the number of paces taken in a particular direction etc. This activity could then be developed by showing learners a number of methods written to varying levels of detail for a number of scientific procedures. Discuss with learners which method is best and why – which would give high quality data/results etc. Learners could then complete OCR's Lesson Element 'Getting the 'Write' Instructions'.	30 minutes–1 hour	R075: LO3

Suggested content	Suggested Activities	Suggested timings	Links to other units
9 Sampling techniques 	Learners could briefly discuss the role of an ecologist and link this to the idea that they need to collect representative samples from different environments etc. Discuss the different methods that could be used to collect various sets of data. Learners could describe how they would sample the number of daisies on the school field. Using a quadrat, learners could then find the number of daisies on the school field. Learners must be aware of the importance of sample size and the number of repeats and random sampling etc. Learners could also use a transect to measure the distribution of organisms across a school path. Learners can then interpret the data using appropriate mathematical methods. Learners could be given a bowl of coloured sugar coated chocolate beans. They should be told that they have been asked to find out the number of different pigments in the blue beans. Learners could discuss which scientific method they can use to carry out this test and the number of tests they should do. Learners could explain what and why they have decided to do, for example one or more tests, using the same bean, tests on more than one bean (and how many?) etc.	1 hour–1 hour 30 minutes	R074: LO2
10 Quality of data 	Learners could be given sets of data from a number of different learner experiments. Learners could then discuss which sets of results represent reproducible data and repeatable data and explain why.	30 minutes	R075: LO3
	Learners could watch a shampoo advert (or any advert that makes claims based on surveys/studies), they should then discuss if they think the surveys are reliable etc. For example, how large was the sample size, when was it carried out, can the claims the advert make be substantiated by the data available? How could the claims be made more reliable?	30 minutes	R075: LO3
	Learners could develop their critical thinking skills by completing the 'Boiling point' activity found at the following web link: http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/639/2.%20boiling%20point.pdf	30 minutes	R075: LO3
11 Accuracy of measurements	Learners could complete the 'Measuring the radius of a marble' experiment which can be found at www.nuffieldfoundation.org/practical-physics/measuring-radius-marble. This experiment will develop the skills involved in devising experimental methods which improve the accuracy of measurements. Teachers notes and an extension task are detailed on the web page.	30 minutes	R075: LO3

Suggested content	Suggested Activities	Suggested timings	Links to other units
12 Interpreting evidence and suggesting conclusions 	These activities give learners the opportunity to interpret data and suggest conclusions. Learners could be given a set of data, for example planetary data, they could then be asked to suggest what the data tells them, what relationships they can identify etc. Learners should be encouraged to use science to explain their conclusions. This activity is detailed, with data, in OCR's Lesson Element 'Interpreting Evidence and Suggesting Conclusions Activity 1'. Learners could be given data from a number of cation and anion flame tests, they could then be asked to interpret the data. This activity is detailed, with data, in OCR's Lesson Element 'Interpreting Evidence and Suggesting Conclusions Activity 2'.	Activity 1 40 minutes Activity 2 20 minutes	R074: LO2, LO3, LO4, LO5, LO6 R075: LO3
13 Reporting findings in detail and in an appropriate format 	Learners could be given a set of data from an experiment (such as an investigation into the extension of a spring with different masses attached to it). Learners should be made aware of their target audience (eg KS4 learners, the scientific community, the general public etc). Learners then study the data and decide how to present it to best meet the needs of their target audience. Learners should decide if they need to tabulate the data, how best to present it visually ie as a pie chart, bar graph, line graph etc. Learners should be reminded about the need for labels and the use of appropriate scales for the axis etc. Learners need to decide how they will explain/interpret the data to their target audience. This activity is supported by OCR's Lesson Element 'Reporting Findings'.	1 hour	R075: LO4
14 Suggesting and justifying experimental improvements 	Learners could be given a method for a particular experiment, such as the chromatography of a leaf or colourimetry of a coloured solution etc. Learners carry out the procedure and record their results and findings, completing the experimental write up process. Learners could then discuss as a class and record the ways in which the experiment could be improved (such as more repeats, more precise measuring equipment, what were the control variables and were all the variables that should be controlled effectively controlled, how often where measurements taken etc). Learners could be encouraged to justify/explain why they have made these suggestions and how they will improve the reliability, repeatability and reproducibility etc of the data. The discussion could also lead on to how the experiment could be extended to answer other questions.	1 hour–1 hour 30 minutes	R074: LO2, LO3, LO4, LO5, LO6

LEARNING OUTCOME 2 - BE ABLE TO SEPARATE AND IDENTIFY THE SUBSTANCES PRESENT IN A MIXTURE

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Chromatography: developing understanding 	Learners could become familiar with/recap the keywords associated with chromatography by completing a card sort (meaning and definition) activity. OCR's Lesson Element 'Chromatography keywords' supports this activity.	15 minutes	R075: LO2
	Learners could develop further understanding of this topic by completing the activity 'Chromatography' found at the following weblink: http://www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/642/4.%20chromatography.pdf?v=1363886492010	15 minutes	R075: LO2
2 Chromatography techniques 	Learners could carry out chromatography techniques in a number of ways. For example, learners could recap the basics of photosynthesis, which would lead in to the separation of the pigments in a leaf. Learners should be encouraged to record all aspects of the process as they complete the task to practice and reinforce understanding. To support this activity, learners could complete the experiment 'Chromatography of leaves' found at the following web link: www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/458/cce-4.pdf?v=1363886777102 Teaching tips and answers are provided on the webpage.	1 hour	R075: LO2
3 Calculating R_f values and making comparisons 	Learners could be given diagrams of chromatograms that have previously been produced or use chromatograms from experiments they have carried out. They can then use these to work out the R_f values for each dye present in the sample. Learners could then look up these R_f values in tables to identify them or compare them against standards they have run to identify them. Learners should be encouraged to show their working at all stages of their calculations. This task could be based on the identification of food colourings in fruit juices for example, or the amino acids present in a food stuff. The correct R_f value can be looked up to identify the amino acids/food colourings present. A sample experiment can be found at the following website: www.biotopics.co.uk/as/amino_acid_chromatography.html	1 hour	R075: LO2
4 Gel electrophoresis process 	If the school has an electrophoresis set this could be used as a visual demonstration for the introduction of gel electrophoresis. Alternatively, learners could be introduced to gel electrophoresis by accessing the following website which has a virtual lab tutorial to help with this topic: http://learn.genetics.utah.edu/content/labs/gel/. Learners could then research the process of gel electrophoresis and its uses.They could produce a poster aimed at a particular audience, eg other learners, the general public etc. Learners would need to include detailed step by step instructions on how to set up gel electrophoresis, how it works and details on where it is used etc.	1 hour–2 hours	R075: LO4

Suggested content	Suggested Activities	Suggested timings	Links to other units
5 The use of Gas Chromatography (GC) and High Performance Liquid Chromatography (HPLC) 	Learners could research the uses of Gas Chromatography (GC) and High Performance Liquid Chromatography (HPLC). Learners could address a number of points including: finding the name of the gas that travels through the machine, an explanation of how the mixture becomes separated and how the machine works. Learners could find an example of graphs that both methods produce and add annotations to explain what they are showing. Learners could provide explanations about: - the peaks (the number and position etc) - why standards are used - retention times - why Gas Chromatography is better than paper chromatography in terms of analysis etc. Learners could construct a table summarising the advantages and limitations of HPLC and GC.	1 hour	R075: LO1, LO4
6 Analysis: starter for 10 	Learners could develop their learning by completing the Analysis worksheet, which focuses on Mass spectrometry and Infra-red spectroscopy found at the following web link: www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/414/RSC%20Starter%20for%20Ten%20-%2010%20%20Analysis.pdf?v=1369037455505 Answers are available at the end of the worksheet.	30 minutes	R075: LO1, LO4

LEARNING OUTCOME 3 - BE ABLE TO EXAMINE AND RECORD FEATURES OF SAMPLES

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Hand lens/magnifying glass	Learners could use a hand lens or magnifying glass to examine a range of samples (eg different rocks and sand, different seeds, different food stuffs etc). Learners could draw what they see with annotations (sizes/distances etc) and record any observations they make. Learners could use reference material to help identify what they are looking at.	20 minutes	R075: LO1, LO2
2 The basics of a light microscope	Learners could be given a diagram of a light microscope and be asked to label it and explain the function of each part. Learners could learn the functions of each part of the microscope by doing a card sort activity. OCR's Lesson Element 'Light Microscope Card Sort' can be used for this activity. Learners could watch a demonstration of how to set up a light microscope for viewing specimens. They could then draw a flow diagram identifying the main stages of setting up a microscope, including how to safely carry a microscope.	45 minutes	R075: LO2
3 Under the microscope	Learners could view pre-prepared slides (mammalian tissue, plant tissue etc) under the light microscope and then draw what they see with annotations.	30 minutes–1 hour	R075: LO2
4 Preparing slides	Learners could watch a demonstration of how to prepare their own slides, for example onion or cheek cells, or stomatal leaf peels. OCR's Lesson Element 'Preparing Onion Cell Slides' provides an opportunity for learners to carry out this activity. Learners could then draw a flow diagram to explain the stages involved in preparing a slide for the light microscope. Learners could then prepare their own slides and draw and annotate what they see. Learners could view woodlice under the microscope under supervision ensuring no harm to the woodlice.	1 hour–1 hour 30 minutes	R075: LO2
5 Light microscope - advantages and disadvantages 	Learners could summarise in a table the advantages and disadvantages of using a light microscope. Learners could examine hair samples and fingerprints using a hand lens/ magnifying glass and then examine the same samples under the light microscope and explain which instrument is better to view these samples and why.	30 minutes	R075: LO2
6 How big is a…? 	Learners could be shown the 'How big is a…?' animation at www.cellsalive.com/howbig.htm which compares the relative sizes of cells and organisms sitting on a pinhead. This can lead on to a discussion about the size of things and how we can accurately work this out.	15 minutes	R075: LO2
7 Calculating magnification 	Learners could be taught about how to work out actual size and magnification of cells. Learners could be given OCR's Lesson Element 'Calculating magnification' to support this introduction. Learners could then use a graticule on a microscope to work out the size of pre-prepared slides.	30 minutes–1 hour	R075: LO2

Suggested content	Suggested Activities	Suggested timings	Links to other units
8 Blood cells 	Learners could be taught about the components of blood. This can then be developed into the forensic aspects of observing blood splatters etc at crime scenes. Learners could be given pictures of blood cells and taught how to work out actual size and magnification from the information given. Learners could also record any other features they notice. Learners could then use a graticule on a microscope to work out the size of blood cell from pre-prepared slides.	1 hour	R075: LO2
9 Alternative techniques - electron microscopy	Learners could visit a local university or research laboratory where they could watch a demonstration of an electron microscope, including explanations of tissue sample preparation etc. Learners could compile a questionnaire before their visit of relevant questions to ask the microscope operators (such as details of resolution etc).	2–3 hours	R075: LO1
10 Electron microscope - advantages and disadvantages 	Learners could watch this video clip on the functions of light and electron microscopes and then use the information to produce a poster/factsheet about the electron microscope and its advantages/disadvantages. Learners could work in groups. www.bbc.co.uk/schools/gcsebitesize/science/videos/microscopy_video1.shtml	1 hour	R075: LO1, LO4
11 X-ray analysis and ultrasound 	Using the following video clip and BBC Bitesize link as a starting point, learners could research the uses of ultrasound and X-rays as a way of viewing hidden structures, and structures difficult to access. Learners should be guided in this task so they focus their research in the correct areas. Learners could create a 5 minute class presentation of their findings. Learners should be encouraged to incorporate ICT into their presentations. Learners could peer assess each other's presentations and suggest steps for improvement. X-rays: www.bbc.co.uk/learningzone/clips/x-rays/4553.html Ultrasound: www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/radiation/ultrasoundrev2.shtml	1 hour–1 hour 30 minutes	R075: LO1, LO4

LEARNING OUTCOME 4 - BE ABLE TO IDENTIFY CATIONS AND ANIONS IN SAMPLES

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Flame tests for cations	Learners could be asked how they think fireworks get their different colours, or why street lamps are the colour they are. This could lead on to a discussion about colours and the use of metals. Learners should then follow a standard procedure for carrying out flame tests on a range of cations. Learners could complete the activity 'Flame Tests' found at the following website: www.creative-chemistry.org.uk/activities/flametests.htm. Teacher notes and answers are available at the end of the activity. All relevant risk assessments must be carried out – learners could also be asked to risk assess the procedure. Learners should record all observations. A class discussion of results could follow, or alternatively learners could be encouraged to try and explain their results by researching on the internet using websites such as www.chemicalconnection.org.uk/chemistry/topics/view.php?topic=3&headingno=5&lang=en. This technique could then be linked to forensic science by asking learners how it could be useful to a forensic scientist. Learners could then be given samples of unknown substances and asked to identify the metals present in them. The activity 'Flame test: (wooden splint method)', found at the following web link could be used to support this learning: www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/838/cfns%20experiment%2079%20-%20flame%20tests%20(wooden%20splint%20method).pdf?v=1364648453376).	1–2 hours	R075: LO1, LO2, LO4
2 Flame tests for cations	A teacher demonstration on flame colours (for example www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/839/CFNS%20Experiment%2080%20-%20Flame%20colours%20-%20a%20demonstration.pdf) could be carried out; learners create a flow diagram of the procedure and record the results in a table. A class discussion following the demonstration could explain the results. The procedure could then be linked to forensic science through discussion and question and answers.	1 hour	R075: LO2
3 Flame tests: consolidation 	Learners could consolidate their learning by producing a poster/factsheet explaining the uses of flame tests, how to carry them out and the science behind them. Learners could be given some data to interpret to support this consolidation.	1–2 hours	R075: LO1, LO2, LO4

Suggested content	Suggested Activities	Suggested timings	Links to other units
4 Chemical tests for cations 	Following a standard (risk assessed) procedure with sodium hydroxide and cations, learners could carry out precipitation tests on known samples of cations (aluminium Al^{3+}; copper, Cu^{2+}; iron(II), Fe^{2+}; iron(III), Fe^{3+}; lead, Pb^{2+}), recording their results and observations. Learners could also risk assess the procedure themselves. OCR's Lesson Element 'Chemical Tests for Cations' can be used for this activity. A class discussion of results could follow the tests. An alternative form (microscale version) of the procedure can be found at: www.nuffieldfoundation.org/practical-chemistry/reactions-positive-ions-sodium-hyroxide-microscale-version Teacher notes and expected results are available at the end of the activity.	1 hour	R075 LO1, LO2
5 Chemical tests for anions 	Following a standard (risk assessed) procedure to test for anions (carbonate CO_3^{2-}, chloride Cl^-, sulfate SO_4^{2-}) learners could carry out tests on known samples recording their results and observations. Learners could also risk assess the procedure themselves. A class discussion of results could follow the tests. The following web links could be used to support this activity: www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/534/cce-80.pdf?v=1364648589268 www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/837/cfns%20experiment%2078%20-%20testing%20for%20negative%20ions.pdf Teacher notes and expected results are available.	1 hour	R074: LO1 R075: LO1, LO2
6 Testing for ions interactive quiz	As a revision of the chemical testing for ions, learners could access the interactive quiz at the following website and answer the questions as they go through. www.absorblearning.com/chemistry/demo/units/LR1106.html#Introduction	30 minutes	
7 Inferences: starter for 10 	Learners could complete section 11.5 'Inferences' of the 'Starter for 10: Experimental Skills' worksheet (at the following web link) to test their knowledge on cations and anions. www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/415/RSC%20Starter%20for%20Ten%20-%2011.%20Experimental%20Skills.pdf?v=1364058866623 Answers are available at the end of the worksheet.	30 minutes	

Suggested content	Suggested Activities	Suggested timings	Links to other units
8 Ion chromatography, atomic emission spectroscopy (AES) and inductively coupled plasma-atomic emission spectroscopy (ICP-AES) 	Learners could visit a local university or research laboratory where they could watch a demonstration of ion chromatography, atomic emission spectroscopy (AES) and inductively coupled plasma-atomic emission spectroscopy (ICP-AES). Before their visit learners could compile a questionnaire of relevant questions to ask the operators (such as the advantages and disadvantages of using these instruments with respect to improved separation, quantification and sensitivity), how they work, how they are set up etc. Learners could use the information to produce a factsheet/presentation to the rest of the class/guide to the three different techniques.	½–1 day	R075: LO1
9 Ion chromatography, atomic emission spectroscopy (AES) and inductively coupled plasma-atomic emission spectroscopy (ICP-AES) -Research activity 	Learners could use the internet to research the three techniques (ion chromatography, atomic emission spectroscopy and inductively coupled plasma atomic emission spectroscopy) and produce a fact sheet/ guide/presentation to the rest of the class on the three techniques (alternatively different groups of learners can research one of the techniques and learn from other groups about the other two techniques). The work produced could be peer assessed by the rest of the group giving steps for improvement etc. If each group has only researched one technique, they could be asked to produce a short fact sheet containing the main points which can be given to the other groups. Teachers should check work for accuracy before distributing learners' fact sheets.	2 hours	R074: LO4 R075: LO1, LO4

LEARNING OUTCOME 5 - BE ABLE TO DETERMINE THE CONCENTRATION OF AN ACID OR BASE USING TITRATION

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Titrations 	Following an explanation/recap of neutralisation and the introduction of the idea that we can use titration as a way of determining the concentration of an acid/base, learners could carry out a simple titration to practice the procedure. The following web links could be used to support this activity: www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/502/cce-48.pdf?v=1364057359835 Teaching tips and answers are provided. http://media.rsc.org/Classic%20Chem%20experiments/CCE-60.pdf Teaching tips are provided. Learners could carry out titrations 3 times to get a set of data with which they could then use to calculate the mean.	1 hour	R075: LO1, LO2
2 Investigation of indicators	Learners could carry out the practical 'Investigation of indicators' described in the 'Acids and Alkalis' document available at the following web link. The practical can be found on page 12 (Activity 4). www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/947/Acids%20and%20Alkalis.pdf Teachers notes and answers are provided.	1 hour– 1 hour 30 minutes	
3 Titrations: starter for 10	Learners could complete section 11.3 'Titrations' of the 'Starter for 10: Experimental Skills' worksheet (at the following web link) to test their knowledge on titrations. www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/415/RSC%20Starter%20for%20Ten%20-%2011.%20Experimental%20Skills.pdf?v=1364058866623 Answers are provided at the end of the worksheet.	15 minutes	

Suggested content	Suggested Activities	Suggested timings	Links to other units
4 Calculation of concentration 	Learners could be supported through some sample calculations of finding the concentration of an acid/base (maybe from their own titration experiments). Learners could then be given a set of data (if not using their own) to practice calculations. Learners could then complete section 1.6 'Titration calculations' of the 'Starter for 10: Quantitative Chemistry' worksheet (at the following link) to test their knowledge. www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/406/RSC%20Starter%20for%20Ten%20-%201.%20Quantitative%20Chemistry.pdf?v=1364059065991 Answers are provided at the end of the worksheet.	30 minutes–1 hour	R075: LO2
5 Alternative techniques offering enhanced accuracy and sensitivity eg pH meter and auto-titration. 	Learners could assess the uses (advantages and disadvantages) of a pH meter and autotitration rather that the titration procedures they have used. This could be done by research on the internet or possibly a visit to a research laboratory. This information could be presented as a table.	1 hour	R075: LO1, LO4

LEARNING OUTCOME 6 - BE ABLE TO DETERMINE THE CONCENTRATION OF COLOURED SUBSTANCES IN SOLUTION

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Visual comparison with standards 	Learners could complete OCR's Lesson Element 'Visual Comparison with Standards' to gain an understanding of how scientists make visual comparisons with solutions of known concentrations ('standards') and what the advantages/disadvantages of this method are. This activity can lead into a group discussion about the use of colorimeters.	1 hour	R075: LO1, LO2
2 The use of colorimetry and plotting and using calibration curves 	After being taught the science behind colorometry, including the need to use the correct filters and calibration etc, learners could set up a series of standard solutions and test their absorbencies (learners would need to decide on the correct filter). A calibration graph can then be created (learners may need advice on how to construct this initially). A sample of unknown concentration could then be given to the learners, who can then measure the absorbance and arrive at a concentration using their calibration curve. Learners could then draw a flow diagram of the method they used in their laboratory notebooks and record all their results in a suitable table. Learners could construct a table of advantages and disadvantages of using colorometry compared to visual comparisons. Learners could use the solutions they set up in the visual comparison task to test their absorbancies, getting a more sensitive and accurate set of data. Learners could compare the two sets of data which could then be linked to the idea of using further techniques to obtain an answer. There is a practical at the following web link which uses colorimetry which may be useful to learners: www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/528/cce-74.pdf?v=1364649540110 Teaching tips and answers are provided.	1 hour– 1 hour 30 minutes	R075: LO1
3 Spectrophotometer 	Learners could research the use of a spectrophotometer and summarise the advantages and disadvantages.	30 minutes	R075: LO1, LO4

UNIT R075 - HOW SCIENTIFIC DATA IS USED

Guided learning hours : 30

PURPOSE OF THE UNIT

The focus of learning for this unit is the way in which scientists obtain, analyse, evaluate and communicate scientific information. This unit is taught in the context of the analytical techniques experienced in unit R074, and the teaching of unit R075 may be integrated with R074.

Learners will have carried out basic analytical techniques in the classroom, but they now consider the benefits and applications of the more sophisticated techniques available in the modern workplace.

In LO1, learners consider the limitations of techniques and processes when collecting data. LO2 focuses on analytical techniques, both qualitative and quantitative, whilst LO3 looks at how data and conclusions can be evaluated. In LO4 learners are taught the relevant scientific conventions for the effective communication of scientific ideas and data.

Learners will bring to this unit skills, knowledge and understanding from Unit R074, including the use of scientific equipment to collect data and the interpretation of data to reach conclusions.

Learning Outcome - The learner will:
1 Know and understand how scientists obtain scientific information
2 Know and understand how scientists analyse and process information
3 Know and understand how scientists evaluate information
4 Be able to communicate scientific information

LEARNING OUTCOME 1 - KNOW AND UNDERSTAND HOW SCIENTISTS OBTAIN SCIENTIFIC INFORMATION

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Identification and control of variables	Learners could complete OCR's Lesson Element 'Identifying and Controlling Variables', which gives a range of case studies describing some simple and more detailed investigations. Learners are asked to identify the control, independent and dependant variables.	30–40 minutes	
2 The use of more than one technique to obtain an answer	Learners could be given a forensics scenario where there is some evidence. Learners could decide what tests they would need to carry out to get data, and then discuss (maybe as a class discussion) if those results would be reliable etc. This could lead on to learners suggesting further (more sensitive) tests to try and make their data more reliable. The following video on 'Crime Scene Investigation' could be shown to set it into a forensic scenario www.bbc.co.uk/learningzone/clips/crime-scene-investigation/10871.html	30 minutes	R075: LO3
3 The use and limitations of equipment to obtain information 	Learners could complete the experiment 'Stretchy Sweets' available at www.nuffieldfoundation.org/practical-physics/stretchy-sweets - this experiment can be used for a variety of purposes, including making measurements, load-extension, and variation and range. Teaching notes and an extension activity are provided.	30 minutes–1 hour	R075: LO3
4 The collection of samples 	Learners could be shown the 'Crime Scene Investigation' video available - www.bbc.co.uk/learningzone/clips/crime-scene-investigation/10871.html This could lead to a discussion about how the collection of samples must be carried out carefully to avoid contamination, and confusion etc. Learners could suggest how contamination could be avoided, how they could avoid disturbing the samples on the way back to the laboratory, how they would be able to identify where and when the samples were taken and how they should be stored. Learners could be told that they are going out on to the school field to take samples of soil from different sites of the field to test for water content. Before they go out learners could create a flow diagram of the procedures they will follow including all the equipment they would need, along with step by step instructions. Learners should consider how and why to avoid contamination, how to document where they got the sample from, how they would get the sample back to the laboratory, how they would store the samples etc.	1 hour–1 hour 30 minutes	

LEARNING OUTCOME 2 - KNOW AND UNDERSTAND HOW SCIENTISTS OBTAIN SCIENTIFIC INFORMATION

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Experiment calculations 	Learners could complete OCR's Lesson Element 'Experiment Calculations', which gives a range of case study data from, a number of experiments. Learners complete a set of questions for each case study, which include calculating the mean of each set of data, along with the range and percentage error.	30–45 minutes	
2 Treatment of errors: starter for 10 	Learners could complete section 11.2 'Treatment of errors' of the 'Starter for 10: Experimental Skills' worksheet (at the following web link) to test their knowledge on errors. www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/415/RSC%20Starter%20for%20Ten%20-%2011.%20Experimental%20Skills.pdf?v=1364058866623 Answers are provided at the end of the worksheet.	30–45 minutes	R075: LO1

LEARNING OUTCOME 3 - KNOW AND UNDERSTAND HOW SCIENTISTS OBTAIN SCIENTIFIC INFORMATION

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Observation exercises	Learners could complete section 11.4 'Observation Exercises' of the 'Starter for 10: Experimental Skills' worksheet (at the following web link) to test their knowledge on observations. www.rsc.org/learn-chemistry/content/filerepository/CMP/00/001/415/RSC%20Starter%20for%20Ten%20-%2011.%20Experimental%20Skills.pdf?v=1364058866623 Answers are provided at the end of the worksheet.	30 minutes	R075: LO1
2 To use scientific information to make a conclusion 	Learners could be given a scenario with some evidence and data. Learners could then be asked what conclusions they can draw from this and importantly what further evidence/tests/results they need to make the conclusion more reliable. The Lesson Element 'Making Conclusions' supports this activity.	30 minutes	R075: LO1

The following activity can be used to support R075 learning outcomes 1, 2 and 3.

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Scientific design and technique	Learners could access test/revise their knowledge on experimental design and technique using the quiz at the following web page: www.gcsescience.com/hsw20.htm	30 minutes	

LEARNING OUTCOME 4 - BE ABLE TO COMMUNICATE SCIENTIFIC INFORMATION

Suggested content	Suggested Activities	Suggested timings	Links to other units
1 Communication of science 	Learners could be encouraged to present their finding of various research tasks throughout this unit to other class members, staff and the wider community in a number of formats. This could be through presentations (such as PowerPoint), posters, factsheets, videos, drama sketches, interviews, comic strips, flow diagrams, written reports etc. Examples of where would be a good place to use this approach would be the research of electron microscope, GC, X-ray analysis, AES, and ICP-AES. Learners could be asked to imagine that they had just invented a certain technique and they have to try and persuade a potential investor to back them by telling them about the advantages and future applications of their invention.	1 hour–3 hours	
2 Units card sort 	Learners could complete a card match exercise where they must link the correct unit to what it measures and its symbol. OCR's Lesson Element 'Units Card Sort' can be used for this activity.	30 minutes	
3 Think Nano 	Learners could complete the tasks in the 'Think Nano' activity found at the following web page: www.rsc.org/education/teachers/resources/aflchem/resources/45/index.htm These tasks allow learners to work in pairs and groups. Teacher guidance is provided.	30 minutes–1 hour	
4 Astounding numbers 	For more able learners - Learners could try the 'Astounding numbers' exercise found at the following web link: www.rsc.org/learn-chemistry/content/filerepository/CMP/00/000/649/9.%20astounding%20numbers.pdf?v=1364649650075 Learners are required to answer questions based on the information provided and have the opportunity to produce their own questions which can be given to other learners. Teacher guidance is provided.	30 minutes–1 hour	
5 Keywords – scientific method 	Learners could complete a card match exercise containing all the correct and relevant words they should use in their scientific write ups and reports such as, procedure, accuracy, validity, experimental error, hypothesis, prediction, method, observation, etc. OCR's Lesson Element 'Keywords - Scientific method' can be used to complete this activity.	30 minutes	

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