OCR
Oxford Cambridge and RSA

Cambridge **TECHNICALS LEVEL 3**

Cambridge TECHNICALS 2016

APPLIED SCIENCE

Unit 3 – Scientific analysis and reporting
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 have 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 techniques presented in this unit underpin the work of scientists in the collection, analysis and presentation of data and information. The unit will develop your knowledge and understanding of a range of useful analytical techniques that can be applied in experimental and investigative settings. Techniques used in scientific experimentation and analysis must be valid, require the accurate and careful gathering of sufficient data and ultimately its interpretation and reporting.

This unit will build on the laboratory techniques from Unit 2 by adapting and extending these according to requirements and applications.

Scientists must produce reports on their scientific investigations designed to meet the needs of specific audiences. Their findings may be further reported on in the public domain such as in the media.

This unit will develop a learners reporting skills and evaluate those of others. They must report on the scientific techniques they have used, methods designed and selected to analyse the data they have collected and appropriate formats to present their findings.

Unit 3 Analytical techniques	
LO1	Be able to use mathematical techniques to analyse data
LO2	Be able to use graphical techniques to analyse data
LO3	Be able to use keys for analysis
LO4	Be able to analyse and evaluate the quality of data
LO5	Be able to draw justified conclusions from data

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/?qualtype_key=cambridge-technicals/

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 3)	Title of suggested activity	Other units/LOs	
LO1	Calculating surface area	Unit 1 Science fundamentals	LO2 Understand reactions in chemical and biological systems
	Calculating rates	Unit 1 Science fundamentals	LO2 Understand reactions in chemical and biological systems
	Calculating areas	Unit 2 Laboratory techniques	LO2 Be able to separate, identify and quantify the amount of substances present in a mixture
	Serial dilutions	Unit 2 Laboratory techniques	LO3 Be able to determine the concentration of an acid or base using titration
	Using simple equations – substitution – calculating dilutions	Unit 2 Laboratory techniques	LO3 Be able to determine the concentration of an acid or base using titration
LO2	Using graphs (to report and analyse experimental results)	Unit 2 Laboratory techniques	LO1 Understand the importance of health and safety and quality systems to industry
	Using graphs (for calibration)	Unit 2 Laboratory techniques	LO5 Be able to identify cations and anions in samples
LO4	Uncertainty, anomalies and error – collecting high quality data	Unit 2 Laboratory techniques	LO1 Understand the importance of health and safety and quality systems to industry
	Common terms used in experimental analysis and evaluation	Unit 2 Laboratory techniques	LO3 Be able to determine the concentration of an acid or base using titration
LO5	Reporting findings	Unit 2 Laboratory techniques	LO1 Understand the importance of health and safety and quality systems to industry
LO6	Preparation of permanent slides	Unit 2 Laboratory techniques	LO1 Understand the importance of health and safety and quality systems to industry
		Unit 2 Laboratory techniques	LO4 Be able to examine and record features of biological samples
		Unit 8 Cell biology	LO2 Be able to use cytological techniques
		Unit 13 Environmental surveying	LO3 Be able to use field and laboratory techniques to conduct environmental investigations
		Unit 14 Environmental management	LO2 Be able to identify pollution in the environment
		Unit 16 Waste management	LO4 Be able to test air and water emissions
		Unit 18 Microbiology	LO1 Be able to classify and identify microorganisms
		Unit 18 Microbiology	LO4 Understand the action of antimicrobials on microorganisms
	Use of alternative staining procedures in microscopy	Unit 2 Laboratory techniques	LO4 Be able to examine and record features of biological samples
		Unit 8 Cell biology	LO2 Be able to use cytological techniques
		Unit 18 Microbiology	LO1 Be able to classify and identify microorganisms
		Unit 18 Microbiology	LO4 Understand the action of antimicrobials on microorganisms
	Column chromatography	Unit 2 Laboratory techniques	LO2 Be able to separate, identify and quantify the amount of substances present in a mixture
		Unit 2 Laboratory techniques	LO5 Be able to identify cations and anions in samples
		Unit 10 Testing consumer products	LO4 Be able to use extraction and separation techniques on consumer products
		Unit 14 Environmental management	LO2 Be able to identify pollution in the environment

This unit (Unit 3)	Title of suggested activity	Other units/LOs	
LO6	Column chromatography	Unit 16 Waste management	LO3 Understand how waste water is managed
		Unit 19 Crop production and soil science	LO2 Understand factors affecting the growth of crops
		Unit 21 Product testing techniques	LO3 Be able to use quantitative titration techniques on consumer products
	Determination of chloride ion concentration	Unit 2 Laboratory techniques	LO3 Be able to determine the concentration of an acid or base using titration
		Unit 10 Testing consumer products	LO3 Be able to use quantitative titration techniques on consumer products
		Unit 14 Environmental management	LO2 Be able to identify pollution in the environment
		Unit 16 Waste management	LO3 Understand how waste water is managed
		Unit 19 Crop production and soil science	LO2 Understand factors affecting the growth of crops
		Unit 21 Product testing techniques	LO3 Be able to use quantitative titration techniques on consumer products
	Redox titration	Unit 2 Laboratory techniques	LO3 Be able to determine the concentration of an acid or base using titration
		Unit 10 Testing consumer products	LO3 Be able to use quantitative titration techniques on consumer products
	Determination of thiocyanate using iron(III)	Unit 2 Laboratory techniques	LO3 Be able to determine the concentration of an acid or base using titration
		Unit 10 Testing consumer products	LO3 Be able to use quantitative titration techniques on consumer products
LO7	Recording data and plotting graphs	Unit 13 Environmental surveying	LO3 Be able to use field and laboratory techniques to conduct environmental investigations
		Unit 14 Environmental management	LO2 Be able to identify pollution in the environment
		Unit 15 Sustainability and renewable energy	LO4 Be able to recommend sustainable solutions to meet energy demands
		Unit 17 Food technology	LO4 Be able to test product samples
	Scientific report writing	Unit 14 Environmental management	LO5 Be able to carry out and report outcomes of an environmental management study
		Unit 15 Sustainability and renewable energy	LO4 Be able to recommend sustainable solutions to meet energy demands
		Unit 17 Food technology	LO4 Be able to test product samples
	Reporting science	Unit 14 Environmental management	LO5 Be able to carry out and report outcomes of an environmental management study
		Unit 15 Sustainability and renewable energy	LO4 Be able to recommend sustainable solutions to meet energy demands
		Unit 20 Conservation of biodiversity	LO4 Be able to investigate the efficacy of practical measures to conserve biodiversity
	Peer review	Unit 11 Drug development	LO5 Understand the importance of planning clinical trials when introducing new drugs
		Unit 20 Conservation of biodiversity	LO4 Be able to investigate the efficacy of practical measures to conserve biodiversity

KEY TERMS

Explanations of the key terms used within this unit, in the context of this unit	
Key term	**Explanation**
Absolute error	Absolute error is difference between the actual and measured value, which is expressed using the relevant units.
Accuracy	Accuracy is how close a measured value is to the actual (true) value.
Bar graph	A bar graph is a graph using parallel bars of varying lengths.
Binomial nomenclature	Binomial nomenclature is a formal system of naming species of living things by giving each a name composed of two parts, both of which use Latin grammatical forms, although they can be based on words from other languages. It was developed by Swedish scientist Carolus Linnaeus in the 18th century.
Classification system/key	Classification systems are typically used in biology to classify living organisms. A classification key is a means of categorising living organisms by identifying and sorting them according to common characteristics.
Conflicting evidence	Conflicting evidence is a term given to evidence that is taken from different sources that contradict each other.
Continuous data	A set of data is said to be continuous if the values belonging to the set can take on ANY value within a finite or infinite interval.
Controlled variable	In an experiment, a controlled variable is something that is constant and unchanged. Examples are the temperature of the room, or the pressure inside a vessel.
Dependent variable	A dependent variable is a variable (often denoted by *y*) whose value depends on that of another.
Discontinuous (or discrete) data	A set of data is said to be discrete if the values belonging to the set are distinct and separate (unconnected values).
Error	Error is the difference between the actual value of a quantity and the value obtained by a measurement.
Extrapolation	Extrapolation is the process of estimating the value of a variable or function outside the tabulated or observed range. Graphs can be used to estimate values beyond plotted points.
Gradient of a line	The gradient of a line is a measure of rate of change. It can be calculated using: $\text{Gradient of line} = \frac{\text{Change in Y coordinate}}{\text{Change in X coordinate}}$
Histogram	A histogram is a diagram consisting of rectangles whose area is proportional to the frequency of a variable and whose width is equal to the class interval.
Independent variable	An independent variable is a variable (often denoted by *x*) whose variation does not depend on that of another.
Interpolation	Interpolation is the process of estimating a value within two known values in a sequence of values. For a graph this would be between two plotted points.
Interval	Interval is the choice of interval between values. Selection of interval is important as it determines whether or not patterns in data can be identified. An example of interval is readings from an experiment taken at 1°C steps – hence the interval is 1°C.
Kite diagram	A kite diagram is a diagram that typically shows the number of animals (or percentage cover of plants) against distance along a transect. A transect is a line across a habitat or part of a habitat. It can be simply a string placed along the ground, with the number of organisms observed and recorded at regular intervals along the transect.

Explanations of the key terms used within this unit, in the context of this unit	
Key term	**Explanation**
Line graph	A line graph, also called a point-to-point graph, is a diagram in which specific values of a function are plotted as dots on a coordinate plane. Adjacent pairs of dots are connected by straight lines.
Mathematical order (BODMAS)	BODMAS stands for Brackets, Order, Divide, Multiply, Add, Subtract and is often used as a reminder of the sequence to carry out the operations in arithmetic.
Mean	Mean is the average value of a set of data.
Median	Median is the middle value in an ordered set of data.
Mode	Mode is the value that is repeated most often in a set of data.
Outlier	Outliers are data (or values) that lie outside the normal pattern of other data. They could be due to experimental error, or could represent genuine data. They are sometimes removed in order to maintain a trend within the data.
Percentage error	Percentage error shows the error as a percentage of the exact value. It is given by the formula: $Percentage\ Error = \frac{\lvert Approximate\ Value - Exact\ Value \rvert}{\lvert Exact\ Value \rvert} \times 100\%$ Where the $\lvert\ \rvert$ symbol means absolute value i.e. negative becomes positive.
Percentage yield	Percentage yield is the percentage of a product obtained compared to the theoretical maximum (predicted) yield. It is given by the formula: $Percentage\ Yield = \frac{Actual\ Yield}{Predicted\ Theoretical\ Yield} \times 100\%$
Pie chart	A pie chart is a type of graph in which a circle is divided into sectors that each represents a proportion of the whole.
Precision	Precision is how close measured values are to each other.
Primary data	Primary data is data observed or collected directly from first-hand experience. Examples are performing a laboratory experiment or conducting an interview.
Random error	Random errors in experimental measurements are caused by unknown and unpredictable changes in the experiment. These changes may occur in the measuring instruments or in the environmental conditions.
Range	Range is the maximum and minimum values of the independent or dependent variables. Selection of range is important for ensuring patterns in data can be identified. An example of range is readings from an experiment being taken starting at 10°C and ending at 100°C. The range is hence 10°C – 100°C.
Range (or error) bar	A range (or error) bar is a line through a point on a graph, parallel to one of the axes, which represents the uncertainty or error of the corresponding coordinate of the point.
Rate (of change)	Rate of change is the speed at which a variable changes over a specific time period. Rate of change can be determined graphically by calculating the slope of a tangent (line) to a function (graph).
Relative error	Relative error is a measure of the uncertainty of measurement compared to the size of the measurement. The relative error is the absolute error divided by the magnitude of the exact value.
Repeatability	A measurement or experiment is considered repeatable if the original experimenter repeats the investigation using the same method and equipment and obtains the same results.

Explanations of the key terms used within this unit, in the context of this unit	
Key term	**Explanation**
Reproducibility	A measurement or experiment is considered reproducible if the investigation is repeated by another person, or by using different equipment or techniques, and the same results are obtained.
Scatter plot/graph	A scatter plot is a set of points plotted on horizontal and vertical axes. Scatter plots are often used to show the extent of correlation, if any, between the values of observed quantities or phenomena (called variables).
Secondary data	Secondary data is data collected and analysed by someone other than the user. Examples are a text book or a research report.
Serial dilution	Serial dilution is a stepwise process for diluting the concentration of a substance in a solution. Usually each step involves a dilution factor, resulting in the dilution process following a geometric progression. A ten-fold step-by-step dilution is called a logarithmic dilution, and follows a logarithmic geometric progression.
SI units	The International System of Units (abbreviated SI from French: *Le Système International d'Unités*) is the modern form of the metric system and is the world's most widely used system of measurement. It comprises seven base units (from which other units can be derived): The ampere (A) – unit of measurement of electric current The kilogram (kg) – unit of measurement of mass The metre (m) – unit of measurement of length The second (s) – unit of measurement of time The kelvin (K) – unit of measurement of thermodynamic temperature The mole (mol) – unit of measurement of amount of substance The candela (cd) – unit of measurement of luminous intensity
Significant figures and rounding	Significant figures is a term often used when rounding a number. The number of significant figures is the number of figures that carry meaning in the required solution. This may or may not include zeros. For example, 0.0001285 rounded to 3 significant figures is 0.000129 while 30245 rounded to 3 significant figures is 30200.
Standard form	Standard form is a way of writing big and small numbers in powers of 10. In standard form the number is always written as $A \times 10^n$ where A is always between 1 and 10. For example, 15 000 000 is written in standard form as 1.5×10^7.
Straight line equation	The equation of a straight line is written in the form: $y = mx + c$ where m represents the slope (or gradient) of the line and c the y intercept point (the point where the line crosses the y axis).
Substitution (into an equation)	Substitution is the process of replacing letters with numbers in an equation or formula. An example is the formula a + 3b, where a = 2 and b = 3; substituting results in 2 + 3(3), which can then be solved.
Surface area	The surface area of an object is the area of all faces added together.
Systematic error	Systematic errors in experimental observations usually come from the measuring instruments. They usually occur if there is something wrong with the instrument, or with the way it is being used.
Uncertainty	Uncertainty is a term used to express the doubt in a measurement or value. It is often used to quantify the level of uncertainty e.g. 'the temperature is $20^0C \pm 2^0C$'.
Variable	A variable is any factor or condition that can exist in differing amounts or types. An experiment usually has three kinds of variables: independent, dependent, and controlled. In mathematics a variable is a symbol for a value that is not yet known.

Explanations of the key terms used within this unit, in the context of this unit	
Key term	**Explanation**
Variance and standard deviation	Variance is the average of the squared differences from the mean. Standard deviation is a measure of how spread out numbers are in a set of data. Its symbol is **σ** where **σ** = √variance (for population data). For sample data the standard deviation is termed *s* with formula: $s = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}$
Volume	Volume is the quantity of three-dimensional space occupied by an object – and can include solids, liquids and gasses. It is expressed as a cubic e.g. cm^3, mm^3, m^3 etc.

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**
Algebra – mathematical order – BODMAS	Learners might already be familiar with the importance of mathematical order i.e. performing mathematical operations in the correct order. BODMAS is a common acronym representing the order in which mathematical operations should be performed (Brackets, Order, Division, Multiplication, Addition, and Subtraction). BIDMAS is another common acronym (Brackets, Indices, Division, Multiplication, Addition, and Subtraction) and is often used as an alternative. Tutors might wish to remind learners when solving problems manually, using a calculator or using ICT.	http://www.mathsisfun.com/operation-order-bodmas.html http://www.bbc.co.uk/bitesize/ks3/maths/number/order_operation/revision/2/
Application of units	Mathematical operations related to solving scientific problems will invariably result in an answer with units (e.g. mol, mm, newtons, pascals, grams etc). Learners should be encouraged to include the correct units when solving scientific problems.	Practice science problems.
Straight-line equations	Learners might already be familiar with the equation of a straight line. Tutors might wish to recap on straight-line mathematics before learners undertake more complex problems.	http://www.mathsisfun.com/equation_of_line.html
Statistics – variance, standard deviation (population and sample data)	Learners might already be confident in calculating mean, mode and median. Variance and standard deviation are an extension of this. The formula for standard deviation differs for population and sample data, and tutors might wish to reinforce this difference.	http://www.mathsisfun.com/data/standard-deviation.html
Difference between accuracy and precision	Learners often confuse the terms accuracy and precision in the context of measurements. Analogies and examples, such as the dartboard shown in the resources link, might be a way in which to understand and remember the difference. Tutors could reinforce the correct use of other terminology relevant to measurement.	http://www.mathsisfun.com/accuracy-precision.html
Difference between uncertainty and error	The terms uncertainty and error are often used interchangeably and incorrectly. Tutors could demonstrate the difference between these terms using practical examples.	http://www.npl.co.uk/upload/pdf/Understanding%20uncertainty.pdf

SUGGESTED ACTIVITIES

LO No:	1		
LO Title:	**Be able to use mathematical techniques to analyse data**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Using SI units	Tutors could begin this unit with a recap of the SI system of units. Learners might already be familiar with SI units from other units. Resources such as the National Physical Laboratory (NPL) website include an explanation of the history and use of SI and SI-derived units, including videos (http://www.npl.co.uk/reference/measurement-units/). A reference text with worked examples, such as *Maths for Science* by Jordan, Ross and Murphy could prove useful throughout this Unit (http://www.amazon.co.uk/Maths-Science-Sally-Jordan/dp/0199644969/ref=sr_1_1?s=books&ie=UTF8&qid=1439708717&sr=1-1). Resources from the Association for Science Education (ASE) could also prove invaluable: http://www.ase.org.uk/journals/school-science-review/. Tutors could develop practice exercises in the use of SI and SI-derived units for learners to solve. Throughout this Unit, the use of practice exercises related to science will prove useful to reinforce learning and understanding of how to apply analytical techniques.	1 hour	
Standard form 	Scientists are often required to present numbers in standard form (sometimes called 'scientific notation'). Tutors could begin by explaining how to write numbers in standard form (or scientific notation). The following resource includes an explanation of standard form along with worked examples: http://www.mathsisfun.com/algebra/standard-form.html. Learners could practice solving problems to convert numbers to standard form. These problems could also include the use of correct SI units.	1 hour	
Converting numbers between fractions, decimal and standard form 	Another useful technique is being able to convert interchangeably between fractions, decimals and standard form. Tutors could develop example and practice activities showing how to convert numbers. The following web-based resource shows how to convert numbers, and includes worked and practice examples: http://www.mathsisfun.com/converting-fractions-decimals.html.	2 hours	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Significant figures and rounding 	Calculations often result in numbers that require rounding. Rounding involves determining the number of significant figures. Tutors could begin by explaining what is meant by 'significant figures' and how to round numbers. The following series of videos explains how to use significant figures when rounding numbers: http://www.youtube.com/watch?v=5UjwJ9PIUvE&list=PL3hPm0ZdYhyy0PQUQ1ka94hxVQPdYGS9m. Learners could practice solving rounding problems which might require the use of a calculator to determine initial (unrounded) values. Tutors could emphasise the need to use significant figures and rounding appropriately in scientific calculations in order to obtain sensible and sufficiently accurate solutions. The following web-based resource shows how to round numbers: http://www.mathsisfun.com/rounding-numbers.html.	1 hour	
Finding mean, mode and median 	Mean, mode and median are statistical methods used to analyse data. They are often used in scientific studies. Tutors could begin by explaining the terms mean, mode and median and by showing worked examples relevant to science. Web-based resources such as the following could prove useful: http://www.purplemath.com/modules/meanmode.htm and http://chemistry.about.com/od/workedchemistryproblems/a/Mean-Median-Mode-And-Range.htm. Learners could practise solving problems – the raw data for which could have been obtained by learners as part of a study or experiment.	2 hours	
Using simple equations – substitution 	Scientists often use formulae when performing scientific investigations. Formulae describe the relationship between dependent and independent variables – covered later in LO4. They also describe scientific laws. Tutors could explain and demonstrate how to perform calculations which involve substituting values into an equation/formula (see http://www.mathsisfun.com/algebra/substitution.html). They could reinforce the importance of performing mathematical operations in the correct order i.e. BODMAS (see http://www.skillsyouneed.com/num/bodmas.html). Learners could practice solving substitution problems involving simple mathematical operations (such as add, subtract, divide and multiply), and ones involving more complex operations such as roots, powers and reciprocals.	2 hours	Unit 2 LO3

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Calculating percentage error and percentage yield 	Being able to determine percentages is useful for scientists. Examples of where percentages are useful are in calculating percentage errors in an experiment and percentage yield in a chemical reaction. Tutors could show learners how to calculate percentage error and percentage yield. The following resources could be useful: http://www.mathsisfun.com/numbers/percentage-error.html (percentage error) and http://www.docbrown.info/page04/4_73calcs14other2a.htm (percentage yield). Learners could practice solving problems involving percentages – and might be able to relate this to practical experiments they have performed.	2 hours	
Surface area and volume of simple shapes 	Calculating surface area is useful in science for problems such as those involving evaporation and radiation. Volume can be used to determine the amount of substance a vessel can hold (and the mass of the substance). Tutors could begin by showing learners how to calculate the surface area of simple shapes – such as those shown here http://www.basic-mathematics.com/surface-area-formula.html. The following interactive resource could also be useful: http://www.mathopenref.com/surface-area.html. They could also show how to determine the volume of simple shapes (see http://www.mathsisfun.com/geometry/solid-geometry.html). Learners could practice solving problems – which the tutor might be able to relate to a scientific context such as determining evaporation or radiation from an object, or amount of substance in a vessel. Tutors might extend this activity by showing learners how to determine the surface area and volume of simple composite shapes. The following web-based resource could prove useful: http://www.bbc.co.uk/bitesize/standard/maths_ii/measure/surface_comp_solids/revision/2/ with the following video illustrating step by step how to calculate surface area: http://www.youtube.com/watch?v=6Na7dErsljE. Tutors could also show learners how to determine the volume of composite shapes (see http://www.youtube.com/watch?v=z1Pm4dR0Vig).	2 hours	Unit 1 LO2 Unit 2 LO2

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Calculating rate and gradients of a line 	The need to determine reaction rates often occurs in experiments involving chemical reactions. Tutors could explain how to calculate reaction rates using suitable examples (see http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/chemical_economics/reaction1rev1.shtml). They could also explain the difference between average and instantaneous reaction rates (see http://www.chem.purdue.edu/gchelp/howtosolveit/Kinetics/CalculatingRates.html) and how this relates to determining the slope of a line (see http://www.mathsisfun.com/gradient.html). Learners could solve practice problems where they have to determine rate of a chemical reaction.	2 hours	Unit 1 LO2
Changing subjects of equation 	Being able to change the subject of an equation (i.e. by rearranging) is a useful mathematical technique. Tutors could use suitable examples to show learners how to rearrange and solve formulae relevant to science. The following provides a comprehensive tutorial with practice questions: http://www.mathsisfun.com/algebra/equation-formula.html. Tutors could develop a worksheet with practice problems for learners to solve.	2 hours	
Geometric progression and serial dilutions 	Tutors could relate serial dilutions to the procedure for diluting a chemical substance in the laboratory. The following video shows how serial dilution is used to dilute the concentration of a stock solution: http://www.youtube.com/watch?v=MCrNjHcfcpY. Tutors could illustrate how the steps of a serial dilutions result in a geometric progression. Learners could perform simple experiments in which they prepare a serial dilution, relating this to theory: http://sciencefair.math.iit.edu/techniques/SerialDilution/. A worksheet with practice examples could be developed for learners to practice calculating serial dilutions.	2 hours	Unit 2 LO3

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Uncertainty and error  	Uncertainty and error are terms that relate to measurement – and which are often used incorrectly. The following PDF document from the National Physical Laboratory (NPL) could provide a useful introduction to uncertainty and error: (http://www.npl.co.uk/upload/pdf/Understanding%20uncertainty.pdf). Tutors could demonstrate to learners the solution of scientific problems which involve uncertainty and error. Learners will consider further how to analyse the quality of data in LO4 in this unit. Practice activities could be developed which involve the solution of problems in which the effects of uncertainty and error need quantifying when performing mathematical operations. A set of useful definitions from the Institute of Physics. Includes definitions for terms relating to error and uncertainty: http://www.nuffieldfoundation.org/practical-physics/language-measurements.	2 hours	
Variance and standard deviation  See Lesson Element Variance and standard deviation	Learners should already be familiar with the basic statistical techniques of calculating mean, mode and median of a set of data. Standard deviation and variance are further statistical tools that can be used to analyse a set of data – with standard deviation being useful for analysing how spread out a set of numbers are. The following provides a simple of explanation with an example of standard deviation and variance: http://www.mathsisfun.com/data/standard-deviation.html. It also explains the difference between sample and population data. Tutors could show learners further examples using data relevant to scientific studies or experiments. Learners could practice solving problems involving standard deviation and variance for both sample and population data. This also provides an opportunity to use a spreadsheet (ICT) to perform calculations on a set of data. The following YouTube video explains standard deviation. Includes worked examples and student examples to calculate: http://www.youtube.com/watch?v=09kiX3p5Vek.	2 hours	Unit 2 LO3

SUGGESTED ACTIVITIES

LO No:	2		
LO Title:	**Be able to use graphical techniques to analyse data**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Scatter, line and bar graphs 	Graphs are a useful way in which to present and visualise scientific information, and can also be used to analyse data. Learners might already be familiar with a range of graph plotting techniques. Tutors could begin this subject area with examples of how to produce scatter, line and bar graphs – including their applications in science. The following web-based resource includes an interactive tool for producing graphs: http://www.mathsisfun.com/data/graphs-index.html. Tutors could also explain how graphs are used to present dependent and independent variables (see http://www.youtube.com/watch?v=nzfDvfoBv_g). Learners could practice producing graphs using data supplied by the tutor, or from data obtained during experiments. They should note the correct use of units, correct selection of scale, and appropriate labelling of graphs (e.g. title, axes etc). Graphs could be plotted by hand, and also using a spreadsheet thereby giving an opportunity to develop ICT skills.	2 hours	Unit 2 LO1 Unit 2 LO5
Histograms 	Histograms are another graphical technique used to present and analyse data which is grouped into ranges. Tutors could begin by explaining how to produce a histogram for a suitable scientific example. The following web page shows an example of producing a histogram: https://www.mathsisfun.com/data/histograms.html. Again, learners could practice producing histograms by hand and using a spreadsheet.	2 hours	Unit 2 LO1 Unit 2 LO5
Pie charts and kite diagrams 	Pie charts and kite diagrams are further ways in which to visualise and analyse data. Tutors could explain, with suitable examples, both of these techniques. Once again, learners could undertake practice exercises. The following PDF document (aimed at geography) illustrates a number of ways in which to present and analyse data. The section on producing kite diagrams could prove useful: http://www.educationscotland.gov.uk/Images/GeographyUnit%201_tcm4-121619.pdf.	2 hours	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Continuous and discontinuous data 	When data is numerical it can be continuous or discontinuous. This includes the results of scientific studies or experiments. Tutors could begin by comparing continuous and discontinuous (sometimes termed discrete) data. The following web page provides a useful summary: http://mathbitsnotebook.com/Algebra1/FunctionGraphs/FNGContinuousDiscrete.html. Learners could plot data that is continuous and discontinuous using graphs, such as line and scatter graphs appropriately.	1 hour	
Using range bars 	Range bars (sometimes called error bars) are a way in which to show on a graph the uncertainty with which a data point is plotted. They can be manually added to hand-drawn graphs, or can be added to graphs produced by a spreadsheet automatically. Tutors could show learners examples of the application of range bars when plotting scientific data. Learners could practice adding range bars to graphs that they have drawn, and ones which they have produced using a spreadsheet. The following explains how to add range (error) bars to a spreadsheet: http://scienceblogs.com/dotphysics/2009/01/12/tools-error-bars-on-graphs/. You may wish to use this tutorial explaining how to add error bars to an Excel graph. Website also includes further tutorials showing how to plot graphs and add features using Excel. http://www.excel-easy.com/examples/error-bars.html.	2 hours	
Identifying outliers  See Lesson Element Identifying outliers	Outliers are values that are far away from the main group of data – and which might sometimes be as a result of measurement or human error. They can, of course, represent genuinely correct data. Outliers can affect the way in which data is presented and analysed. Tutors could begin by showing learners examples in which there are outliers – including their effect on data presentation and analysis. The following website gives a useful introduction to outliers: https://www.mathsisfun.com/data/outliers.html with the following illustrating graphical examples: http://everythingmaths.co.za/maths/grade-11/11-statistics/11-statistics-06.cnxmlplus. Practice activities could be developed involving outliers from which learners could produce graphs with and without the outliers present – analysing the effects of their removal.	2 hours	Unit 2 LO5

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Using graphs – rates of change and intercepts 	Learners might already be familiar with straight line equations when calculating rates of change (i.e. gradients) in LO1. Tutors could further emphasise how data that produces a straight line graph can be analysed by writing and equation for the straight line. The following web-based resource explains straight line equations in detail: http://www.mathsisfun.com/equation_of_line.html. Learners could practice writing and solving straight line equation for suitable scientific data.	2 hours	
Using graphs – interpolation and extrapolation 	Graphs can be used to estimate values outside of the data points that have been plotted using interpolation and extrapolation. Tutors could begin by explaining – with suitable examples – what is meant by the terms interpolation and extrapolation. The following short video explains how to estimate values from graphs with an example: http://www.youtube.com/watch?v=Y9HG8q_NuhU. Again, learners could practice interpolation and extrapolation using tutor-produced examples, or by plotting experimental data they have obtained themselves. You may wish to use this tutorial explaining how graphs can be used to interpolate and extrapolate data: http://www.mathsisfun.com/data/scatter-xy-plots.html.	1 hour	Unit 2 LO5

SUGGESTED ACTIVITIES

LO No:	3		
LO Title:	**Be able to use keys for analysis**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Classification systems 	Classification systems are systems used to classify things according to common affinities or relations. In the 18th century, Carl Linnaeus published a system for classifying living things. Tutors could begin with an introduction to classification systems and the work of Carl Linnaeus. The following web-resource provides a thorough introduction to classification systems and classification keys, along with videos: http://www.tigtagworld.co.uk/curriculum-england-year-6/. Learners could independently investigate the origin and application of classification systems and keys, summarising their findings.	1 hour	
Using and constructing keys to collate specimens 	Classification keys are often used in biology to categorise living organisms, although they can find other applications in science. Tutors could continue this topic area by explaining and demonstrating, using simple examples, how keys can be used to collate and identify specimens. The following worksheet could provide suitable examples to be adapted: http://www.saps.org.uk/attachments/article/560/SAPS%20Grouping%20&%20classification%20-%20PartE.pdf. Learners could undertake activities using existing keys, and could also practice producing their own keys using suitable data. They could also perform practical experiments if appropriate. You could use this website with links to many resources showing how to use and produce keys, including classification and dichotomous keys: http://www.internet4classrooms.com/grade_level_help/life_science_identify_organism_with_simple_key_eighth_8th_grade_science.htm.	2 hours	
Using keys to compare primary and secondary data 	Tutors could begin by explaining, with examples, what is meant by primary data and secondary data. The following short video could prove useful: http://www.youtube.com/watch?v=g0plq2E9ZjQ. Learners could continue to develop their understanding of keys by using both primary and secondary sources of data in their interpretation and also in their construction.	2 hours	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Binomial nomenclature 	Tutors could conclude this topic area with a deeper investigation of the way in which organisms are classified according to Carl Linnaeus's taxonomy. They could explain to learners how organisms are classified using binomial nomenclature (involving Latin names) and through the use of classification categories. Learners could be shown how to correctly write and present binomial nomenclature. The following provides a short introduction: http://biology.about.com/od/evolution/a/aa092304a.htm, and the following video explains binomial nomenclature: http://www.youtube.com/watch?v=CKHqO7x25VE. Learners could investigate binomial nomenclature for common living organisms, and how this relates to the binomial classification system.	2 hours	

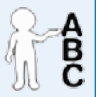
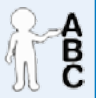
SUGGESTED ACTIVITIES

LO No:	4		
LO Title:	**Be able to analyse and evaluate the quality of data**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Common terms used in experimental analysis and evaluation 	Tutors could begin this learning outcome by introducing learners to the terminology commonly used in experimental analysis and evaluation. Guides available from the Association for Science Education (ASE) (see: http://www.gettingpractical.org.uk/) such as *The Language of Measurement* will prove useful (see http://www.gettingpractical.org.uk/Books.php). This guide includes a definition of common terminology along with examples of its application. Learners could begin to identify the correct terminology relating to aspects of practical experiments they have performed. Some of these will be explored in further detail throughout this learning outcome. This whole learning outcome could be delivered in the context of practical work that learners are undertaking.	1 hour	Unit 2 LO3
Understanding variables 	Variables are data that changes during a study or experiment. Variables can be dependent on some other quantity (such as time), or can be independent. Tutors could begin by explaining the difference between dependent and independent variables. The following video could prove useful: http://www.youtube.com/watch?v=nzfDvfoBv_g. Learners could undertake activities in which they have to identify which data are variables, and which is dependent and independent. The following is a light-hearted activity in which the control group, dependent and independent variables are to be identified: http://www.biologycorner.com/worksheets/controls.html.	1 hour	
Accuracy and precision  See Lesson Element Accuracy and precision	Accuracy and precision are both important terms relating to measurements. Accuracy is how close a measured value is to the true value while precision is how close measured values are to each other. Tutors could explain the terms accuracy and precision, using suitable examples of why they are important (see http://www.mathsisfun.com/accuracy-precision.html). Learners could relate accuracy and precision to practical experiments or suitable examples.	1 hour	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Interval and range 	Interval and range determine the accuracy with which experimental data is collected and analysed. Degrees of accuracy when using measuring instruments and analysing data could be explained along with worked examples (see http://www.mathsisfun.com/measure/error-measurement.html). This can be related to selecting and identifying a suitable range, and measuring instruments with a suitable measurement interval. Tutors could develop a suitable worksheet with problems involving interval and range for learners to solve.	1 hour	
Uncertainty, anomalies and errors 	Practical studies and experiments can produce data that scientists are uncertain of, and sometimes anomalous results. Being able to identify uncertainty and anomalous data is important. Tutors could begin by explaining, with suitable examples, reasons for uncertainty in data and the sources of anomalous results. The following provides a useful overview: http://chemwiki.ucdavis.edu/Analytical_Chemistry/Quantifying_Nature/Significant_Digits/Uncertainties_in_Measurements. Tutors could explain the difference between random and systematic errors, reasons why they occur and how they can be indentified and reduced (see http://www.physics.umd.edu/courses/Phys276/Hill/Information/Notes/ErrorAnalysis.html). A worksheet could be developed for learners to identify and discuss uncertainty and anomalies in experimental data and results. Learners could also relate uncertainty and anomalies to any practical experiments they are performing.	2 hours	Unit 2 LO1
Quantifying error 	Tutors could continue to identify sources of errors in experiments (such as those illustrated here: http://www2.southeastern.edu/Academics/Faculty/rallain/plab193/labinfo/Error_Analysis/06_Sources_of_Error.html). Degrees of accuracy (including range and interval) when using measuring instruments could also be considered as possible sources of error. Error could be quantified and the terms absolute, relative and percentage error explained along with suitable worked examples. Learners could practice by identifying and quantifying error in experiments they are undertaking, or using tutor-generated examples.	2 hours	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Repeatability and reproducibility 	Repeatability and reproducibility are important in being able to produce reliable and credible experimental results. Tutors could begin by defining the terms repeatability and reproducibility and putting them in the context of the 'scientific process'. The following short video explaining the scientific process (which includes repeatability and reproducibility) could prove useful: http://www.youtube.com/watch?v=IX2NPyvYz3w). Learners could investigate the significance of repeatability and reproducibility in scientific experiments, and could find scientific examples of where this good practice has not been adhered to. They could also relate repeatability and reproducibility to experiments and activities they are undertaking practically.	2 hours	

SUGGESTED ACTIVITIES

LO No:	5		
LO Title:	**Be able to draw justified conclusions from data**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Using primary and secondary data to draw conclusions 	Tutors could begin the final learning outcome with a recap of what is meant by the terms primary and secondary data and how this applies to scientific studies. They could also emphasise that in order to be considered credible science requires a systematic and logical approach (sometimes called the 'scientific method'). The following could prove useful: http://www.livescience.com/20896-science-scientific-method.html. Learners could practice identifying primary data and suitable secondary data sources required to make conclusions. They could identify any potential issues or problems with the data. They could apply the scientific method to practical experiments or project work they are undertaking. The following is an interesting article explaining what makes for a secure scientific conclusion, and what does not: http://www.quackwatch.com/01QuackeryRelatedTopics/pseudo.html.	2 hours	Unit 2 LO1
Identifying conflicting evidence 	Being able to identify evidence that is conflicting is important to being able to make sound and credible scientific conclusions. Tutors could use suitable examples to illustrate how evidence can be conflicting – with the following illustrating an example: http://www.exercisebiology.com/index.php/site/articles/studies_are_conflicting_so_i_dont_believe_in_scientific_studies/. The following includes some interesting (real) examples of how conflicting and flawed evidence can lead to what is termed 'bad science': http://www.pharmaceutical-journal.com/opinion/comment/mmr-a-saga-of-bad-science-and-scare-stories-that-swayed-health-professionals/10996275.article and http://healthreadings.com/bad-science-common-problems-in-research-articles/. Learners could investigate scientific studies, identifying where there is conflicting evidence and suggesting how this conflict might be reduced or resolved. They could relate this back to their own practical experiments.	2 hours	Unit 2 LO1
Making secure conclusions 	Tutors could conclude this learning outcome by summarising how the techniques introduced in this unit can be used to make secure scientific conclusions. Learners could be presented with scientific case studies or data from which they have to identify evidence required in order to make a secure conclusion. This could include identifying the reliability of evidence already available, and any further evidence required to make the conclusion more secure. Learners could also use evidence they have obtained through their own practical experiments in order to produce and justify conclusions.	2 hours	Unit 2 LO1

SUGGESTED ACTIVITIES

LO No:	6		
LO Title:	**Be able to use modified, extended or combined laboratory techniques in analytical procedures**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Preparation of permanent slides	As an introduction tutors could recap the technique for making wet and dry slides for the microscope and then learners could prepare slides and view them under a microscope. • Making wet and dry mount slides. • James Finley. • https://www.youtube.com/watch?v=ZjQVQ8gT0A8. • An introduction in making wet and dry mount slides. Learners could then practice the technique of drawing microscope images, remembering to: • Use blank white paper and a pencil. • Start at 40X (low power). • Use a petri dish to make your field of view. • Draw everything you see in the field of view except for the arrow, air bubbles, or dirt. • Make your drawing the same size as the object which you are viewing. • All lines connecting labels should be made with a ruler and drawn parallel to the top of the page with no arrowhead. • All labels should appear outside the field of view. • The title should appear below the field of view on a straight horizontal line with the magnification in parenthesis to the right. Tutors could summarise the preparation of permanent slides by viewing the video: • Permanent slide preparation. • Hooke College. • https://www.youtube.com/watch?v=xIuxzReYp_k. • What is the best way to make permanent slides.	1 hour 30 minutes	Unit 2 LO1, LO4 Unit 8 LO2 Unit 13 LO3 Unit 14 LO2 Unit 16 LO4 Unit 18 LO1, LO4

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Use of alternative staining procedures in microscopy	The tutor could give an overview of staining techniques: • Staining techniques. • Cliffsnotes. • http://www.cliffsnotes.com/study-guides/biology/microbiology/microscopy/staining-techniques. • Introduction to staining techniques for microbiological investigations. Learners could then carry out Gram staining technique to identify fungi such as Candida and Cryptococcus which are observed as Gram positive yeasts. • UK Standards for microbiological investigations. • NHS Public Health England. • https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/457837/TP_39i2.1.pdf. • Staining procedures for bacterial stains, fungal stains, parasite stains.	1 hour 30 minutes	Unit 2 LO4 Unit 8 LO2 Unit 18 LO1, LO4
Column chromatography 	The tutor could recap the technique of thin layer chromatography and then learners could then apply the technique to column chromatography and separate mixtures on a larger scale using a burette packed with silica gel or alumina saturated with solvent. The process of washing a compound through a column using a solvent is elution. • Column chromatography. • Chemguide. • http://www.chemguide.co.uk/analysis/chromatography/column.html. • The site describes the technique of using column chromatography and explains it.	2 hours	Unit 2 LO2, LO5 Unit 10 LO4 Unit 14 LO2 Unit 16 LO3 Unit 19 LO4 Unit 21 LO4

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Determination of chloride ion concentration 	Tutors could introduce Mohr's method to determine the chloride ion concentration of a solution by titration with silver nitrate. As the silver nitrate solution is slowly added, a precipitate of silver chloride forms. The end point of the titration occurs when all the chloride ions are precipitated. Then additional silver ions react with the chromate ions of the indicator, potassium chromate, to form a red-brown precipitate of silver chromate. This method can be used to determine the chloride ion concentration of water samples from many sources such as seawater, stream water, river water and estuary water. Learners could then undertake the titration to determine the chloride ion concentration in seawater. • Determination of chloride ion concentration by titration (Mohr's Method). • University of Canterbery. • http://www.outreach.canterbury.ac.nz/chemistry/documents/chloride_mohr.pdf. • A pdf giving the method for the investigation into the concentration of chloride ions in seawater.	2 hours	Unit 2 LO3 Unit 10 LO3 Unit 14 LO2 Unit 16 LO3 Unit 19 LO2 Unit 21 LO3
Redox titration 	The tutor could review the use of titration to determine the concentration of an acid, base or other substances in solution, calculating the pH at different points of the titration and choosing indicators. Learners could then carry out a redox titration – titrating an Fe(II) solution with potassium permanganate • Redox titration. • Khan Academy. • https://www.khanacademy.org/science/chemistry/acid-base-equilibrium/titrations/v/redox-titration. • An explanation of how to carry out the Redox titration.	2 hours	Unit 2 LO3 Unit 10 LO3
Determination of thiocyanate using iron(III) 	The tutor could introduce the principle that thiocyanate ions react with iron(III) ions in solution to form an intense red coloured complex ion. This reaction can be used for the quantitative analysis of low concentrations of thiocyanate ions. The concentration of the solution of thiocyanate ionscan be found by using a colorimeter. • Determination of thiocynate using Fe(III). • RSC. • Determination of thiocyanate using iron(III). http://www.rsc.org/learn-chemistry/resource/download/res00000906/cmp00001180/pdf. • The pdf shows how the concentration of a solution of thiocyanate can be found using a colorimeter. Learners could then follow the method to plot a calibration curve to find the concentration of thiocyanate ions as ppm thiocyanate in the unknown solution.	2 hours	Unit 2 LO3 Unit 10 LO3

SUGGESTED ACTIVITIES

LO No:	7		
LO Title:	**Be able to record, report on and review scientific analyses**		
Title of suggested activity	**Suggested activities**	**Suggested timings**	**Also related to**
Recording data and plotting graphs 	Tutors could recap on recording data and plotting graphs. • Scientific graphs. • National Science Standards. • http://crescentok.com/staff/jaskew/isr/graph/graph.htm. • An overview of collecting data, plotting graphs and interpreting graphs. Learners could then use data collected from investigation (or given data) and practice plotting graphs and analysing them and consider the quality of the data. Learners could reinforce their understanding by taking the quiz on interpreting graphs. • Interpreting Graphs Review. • ThatQuiz. • https://www.thatquiz.org/tq/previewtest?O/Q/V/J/71441225132068. • Twelve multiple choice questions with answers.	1 hour 30 minutes	Unit 13 LO3 Unit 14 LO2 Unit 15 LO4 Unit 17 LO4
Scientific report writing 	Tutor and learners could discuss how to write a good scientific report, this could be based on the material produced by the Skills Team at Hull university. Scientific report writing Hull University http://www2.hull.ac.uk/lli/pdf/Scientific%20Reports.pdf The pdf goes through how to write a report 'from beginning to end'. Learners could then take the quiz on writing scientific methods to reinforce the discussion: • Scientific method unit test. • ThatQuiz. • https://www.thatquiz.org/tq/previewtest?B/F/Q/C/90551352322409. • Thirty multiple choice questions giving the answers at the bottom of the test.	1 hour	Unit 14 LO5 Unit 15 LO4 Unit 17 LO4

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Reporting science 	Learners could view the video of Professor Colin Blakemore outlining good practice in reporting science stories and then produce a 'tips sheet' on presenting science to the general public. • Reporting science: Colin Blakemore. • BBC. • http://www.bbc.co.uk/academy/journalism/article/art20130702112133767. • Eight minute video on how science stories should be reported to the public.	30 minutes	Unit 14 LO5 Unit 15 LO4 Unit 20 LO4
Peer review 	The tutor could give an overview of peer review: • how the peer review process works. • some of the limitations of peer review. • the role of peer review in society. Learners could produce a summary on peer review and the role of the reviewer who aside from assessing the title, abstract, English language of the article and references, reviewers assess the scientific quality of the work. • Peer Review – The nuts and bolts. • Voice of Young Science network. • http://www.senseaboutscience.org/data/files/resources/99/Peer-review_The-nuts-and-bolts.pdf. • A guide for early researchers on peer review.	1 hour	Unit 11 LO5 Unit 20 LO4

The small print

We'd like to know your view on the resources we produce. By clicking on the 'Like' or 'Dislike' button you can help us to ensure that our resources work for you. When the email template pops up please add additional comments if you wish and then just click 'Send'. Thank you.

Whether you already offer OCR qualifications, are new to OCR, or are considering switching from your current provider/awarding organisation, you can request more information by completing the Expression of Interest form which can be found here: www.ocr.org.uk/expression-of-interest

Looking for a resource?

There is now a quick and easy search tool to help find **free** resources for your qualification:

www.ocr.org.uk/i-want-to/find-resources/

Cambridge Technicals Level 3

Applied Science

textbook

Developed in partnership with Hodder Education this book covers a range of units within this qualification. http://www.hoddereducation.co.uk/Product/9781471874826.aspx

Publication date: 25 Nov 2016

OCR Oxford Cambridge and RSA | HODDER EDUCATION LEARN MORE

Working in partnership to deliver quality resources

www.ocr.org.uk/science
OCR customer contact centre

Vocational qualifications
Telephone 02476 851509
Facsimile 02476 851633
Email vocational.qualifications@ocr.org.uk

OCR is part of Cambridge Assessment, a department of the University of Cambridge. *For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored.*

Cambridge Assessment

CERTIFIED ISO 9001 | UKAS MANAGEMENT SYSTEMS 001