

Cambridge TECHNICALS LEVEL 3

APPLIED SCIENCE

Unit 10 – Testing consumer products
DELIVERY GUIDE

Version 2

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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 outcome so you can see how each activity helps you cover the requirements of this unit.

We appreciate that practitioners are knowledgeable in relation to what works for them and their learners. Therefore, the resources we have produced should not restrict or impact on practitioners' creativity to deliver excellent learning opportunities.

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

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

OPPORTUNITIES FOR ENGLISH AND MATHS SKILLS DEVELOPMENT AND WORK EXPERIENCE

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



English



Maths



Work

Please note

The activities suggested in this Delivery Guide **MUST NOT** be used for assessment purposes. 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

This unit introduces you to regulations governing the nature of consumer products and testing methods used in commercial laboratories. The 'consumer' in this unit is defined as the next purchaser in the chain, not necessarily a member of the public buying a product in a shop.

The 'product' can also apply to results gathered as part of a survey and therefore the results themselves are the product with recommendations made to the relevant audience; for example, in this case of an environmental audit carried out on behalf of a land owner, the product is the findings and conclusions drawn from the audit presented to the land owner.

In this unit, you will have the opportunity of using the knowledge and skills you have gained in the mandatory units, Unit 1 Science fundamentals, Unit 2 Laboratory techniques and Unit 3 Scientific analysis and reporting. You will use a range of laboratory techniques in your investigations from inception, through to testing products. You will both analyse the results gathered from your testing and evaluate your experimental technique making adaptations where necessary to ensure quality of data.

Unit 10 Testing consumer products

L01	Understand the influence of regulatory bodies on development of consumer products
L02	Understand how product testing determines the development of consumer products
L03	Be able to use quantitative titration techniques on consumer products
L04	Be able to use extraction and separation techniques on consumer products
L05	Be able to test the effectiveness of consumer product tests

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/>

Cambridge
TECHNICALS
2016

2016 Suite

- New suite for first teaching September 2016
- Externally assessed content
- Eligible for Key Stage 5 performance points from 2018
- Designed to meet the DfE technical guidance

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 10)	Title of suggested activity	Other units/LOs	
LO1	Consumer products – compiling a manual on regulation	Unit 17 Food technology	LO2 Understand the importance of food safety in food manufacture
	Discussion – the need for good practice in laboratory research	Unit 2 Laboratory techniques	LO1 Understand the importance of health and safety and quality systems to industry
LO2	Discussion of product testing	Unit 2 Laboratory techniques	LO2 Be able to separate, identify and quantify the amount of substances present in a mixture
	Carrying out titrations	Unit 2 Laboratory techniques	LO3 Be able to determine the concentration of an acid or base using titration
	Extracting and separating ingredients from consumer products	Unit 2 Laboratory techniques	LO2 Be able to separate, identify and quantify the amount of substances present in a mixture
	Evaluating testing methods	Unit 3 Scientific analysis and reporting	LO7 Be able to record, report on and review scientific analyses
LO3	Discuss and demonstrate the principles of titration	Unit 2 Laboratory techniques	LO3 Be able to determine the concentration of an acid or base using titration
	Carry out an acid-base titration		
	Carry out a precipitation titration	Unit 3 Scientific analysis and reporting	LO6 Be able to use modified, extended or combined laboratory techniques in analytical procedures
	Carry out a redox titration Carry out a complexometric titration		
LO4	Separating the components of a product using thin-layer chromatography (TLC)	Unit 2 Laboratory techniques	LO2 Be able to separate, identify and quantify the amount of substances present in a mixture
		Unit 3 Scientific analysis and reporting	LO6 Be able to use modified, extended or combined laboratory techniques in analytical procedures
	Research project on micro-analytical techniques	Unit 2 Laboratory techniques	LO5 Be able to identify cations and anions in samples
LO5	Analysing the results	Unit 3 Scientific analysis and reporting	LO1 Be able to use mathematical techniques to analyse data LO2 Be able to use graphical techniques to analyse data LO4 Be able to analyse and evaluate the quality of data LO7 Be able to record, report on and review scientific analyses
	Concluding and evaluating	Unit 3 Scientific analysis and reporting	LO5 Be able to draw justified conclusions from data LO7 Be able to record, report on and review scientific analyses

KEY TERMS

Explanations of the key terms used within this unit, in the context of this unit

Key term	Explanation
Complexometric	A type of volumetric analysis in which the formation of a coloured complex is used to indicate the end point of a titration.
<i>In vitro</i>	A process that is made to occur outside an organism; literally, <i>in vitro</i> means 'in glass'. It usually involves experimentation on cells or tissues in culture.
<i>In vivo</i>	Experimentation that takes place within an organism.
Redox	An oxidation-reduction reaction.
Titration	A type of quantitative analysis used to find the concentration of an analyte.

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
Confusion between <i>in vitro</i> and <i>in vivo</i>, and also, how these relate to clinical trials	Definitions should be reinforced. In drug production, clinical trials are the next step and involve human trials.	Guidance on a strategy for genotoxicity testing of chemical substances Committee on Mutagenicity of Chemicals in Food, Consumer Products and the Environment (COM) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/315800/in_vivo_testing_of_genotoxicity_of_chemicals.pdf An excellent overview of <i>in vitro</i> and <i>in vivo</i> testing in the context of testing for genotoxicity.
That gas chromatography and high performance liquid chromatography give identifications of substances	These techniques separate mixtures, and when retention times are compared with those of standards, or literature values, a tentative identification can be made. This is confirmed, or otherwise, using mass spectrometry – GC-MS or HPLC-MS.	Gas Liquid Chromatography; High Performance Liquid Chromatography – HPLC; The Mass Spectrometer Clark, J. – Chemguide http://chemguide.co.uk/analysis/chromatography/gas.html http://chemguide.co.uk/analysis/chromatography/hplc.html http://chemguide.co.uk/analysis/masspec/howitworks.html Very good introductory guides to GC, HPLC and MS.
Solubility	Many learners think that chemical substances are soluble in one solvent, and not in another, and do not necessarily think that substances can have differing solubilities in a range of solvents. The activity on the extraction of caffeine will help to address this misconception.	Extraction of caffeine Indiana State University, Department of Chemistry and Physics http://carbon.indstate.edu/inlow/LabManuals/Caffeine.pdf Extraction of caffeine from coffee using dichloromethane.

SUGGESTED ACTIVITIES

LO No:	1		
LO Title:	Understand the influence of regulatory bodies on development of consumer products		
Title of suggested activity	Suggested activities	Suggested timings	Also related to
Discussion: Consumer products – what are they?	<p>Learners should begin by gaining an understanding of what consumer products include – they will have various perceptions of this. Strictly speaking, a consumer is the next ‘purchaser’ in any supply chain, so ‘consumer products’ will be very diverse. The breadth of this definition gives scope for centres to tailor practical aspects of this unit to local circumstances.</p> <p>Begin by drawing up a list, though it should not attempt to be definitive as learners should be allowed autonomy in generating their own lists.</p> <p>The list could form the preliminary section in the production of a reference manual on the need for quality control of consumer products, regulatory bodies that oversee the process, and how these bodies influence how quality control is applied.</p> <p>In terms of a conventional definition of consumer products, a starting point would be a discussion of cosmetics, off-the-shelf medical products and nutrient supplements, and household chemicals such as cleaning agents and bleaches. Learners will have encountered these, and carried out some analyses of these in Unit 2 and the extended analytical techniques from Unit 3.</p> <p>This section should form an illustrated introduction to their manual.</p> <p>Learners could use a dictionary, such as the Collins and Oxford English dictionaries, for a definition of a ‘consumer product’.</p> <p>Consumer Product Law and Legal Definition USLegal http://definitions.uslegal.com/c/consumer-product/ A US legal definition of a consumer product, perhaps for discussion/comparison with learner and UK perceptions.</p>	1 hour	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
<p>Consumer products – compiling a manual on regulation</p>	<p>Consumer products are rigorously tested and regulated in their development and before being allowed to be sold, and after sale.</p> <p>A number of regulatory bodies is involved. Learners should carry out research, considering the roles of these agencies and how these, along with the government, influence the quality control of consumer products. Learners will produce a reference manual, describing the requirements and regulations of governing bodies. Learners should produce a foreword to the manual explaining how the governing bodies influence quality control of the products.</p> <p>Learners should review the work of the following regulatory bodies, as a minimum, but centres should note that UK government departments are subject to revision and must check that the information in this guide is still accurate.</p> <p>The Department for Business, Energy & Industrial Strategy (BEIS) is key in negotiating, implementing and transposing a range of consumer product legislation. BEIS works closely with other ministerial departments, e.g. the Department of Health, non-ministerial departments, e.g. the Food Standards Agency, and many public bodies, e.g. the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment. An up-to-date list is given on the government website.</p> <p>Departments, agencies and public bodies The UK government https://www.gov.uk/government/organisations Government ministries, non-ministerial departments and agencies and other public bodies, and who works with whom.</p> <p>Learners should appreciate that other parties involved in consumer products include regulatory bodies within the industry, internal quality control, the media and consumers themselves. These are often overlapping, with reports being commissioned, and responded to, by government. While agencies might report issues with consumer products, other government departments are responsible for aspects of risk management.</p> <p>The Department for Environment, Food & Rural Affairs (Defra) is responsible for helping businesses to measure and report their environmental impacts, including greenhouse gas emissions, and thus aiding identification of how environmental performance can be improved.</p> <p>The Food Standards Agency is an independent department. It works closely with local authority enforcement officers to make sure food law is applied throughout the food chain. The organisation also provides enforcement officers with all the tools they need to ensure that food safety and legal requirements are maintained and monitored in their area.</p>	3 hours	Unit 17 LO2

Title of suggested activity	Suggested activities	Suggested timings	Also related to
<p>Consumer products – compiling a manual on regulation (continued)</p>	<p>The Medicines and Healthcare products Regulatory Agency (MHRA) is approached by customers for regulatory or scientific advice or guidance, or who want to submit an application for a clinical trial or marketing authorisation. The MHRA may suspend a licence to wholesale or manufacture medicines and medical products if it identifies safety issues or needs to investigate a licence holder. In certain circumstances, the MHRA will permanently revoke a licence.</p> <p>The Association of the British Pharmaceutical Industry (ABPI) represents the UK's pharmaceutical companies, engaging with Government and regulators on policy issues of interest to the pharmaceutical industry. Safety monitoring of medicines is a continuous process. Regulation begins early in drug development, during manufacture, testing, then transfer to the clinical trials key to obtaining marketing authorisation, and then after medicines are licenced, and throughout the entire period where a medicine is available for patients to use. Reporting of side effects often observed only after launch, because of their rarity, is an essential role – patients and healthcare professionals are encouraged to report any side effects they experience through the MHRA's Yellow Card reporting scheme or directly to the company that manufactures the medicine. The MHRA monitors closely the repackaging of imported medicines.</p> <p>In the USA, the U.S. Food and Drug Administration (FDA) monitors and regulates consumer products, and its responsibilities are closely related to several other US government agencies.</p> <p>The Chartered Trading Standards Institute (CTSI) helps to safeguard the health, safety and wellbeing of the public, helping local authorities to deliver trading standards regulatory services and liaising with the media to provide consumer safety messages.</p> <p>Department for Environment, Food & Rural Affairs (Defra) https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs/services-information An overview of all of Defra's services and information.</p> <p>Food Standards Agency http://www.food.gov.uk/ Information on the work of the FSA along with news, campaigns and food alerts.</p> <p>Medicines & Healthcare products Regulatory Agency (MHRA) https://www.gov.uk/government/organisations/medicines-and-healthcare-products-regulatory-agency/about https://www.facebook.com/mhragovuk An overview of all of MHRA's services and information.</p>		

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Consumer products – compiling a manual on regulation (continued)	<p>Committee on Mutagenicity of Chemicals in Food, Consumer Products and the Environment, sponsored by the Department of Health and Food Standards Agency https://www.gov.uk/government/organisations/committee-on-mutagenicity-of-chemicals-in-food-consumer-products-and-the-environment A useful link to documents on mutagens in consumer products, from a committee that provides independent advice to government departments.</p> <p>The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT). http://cot.food.gov.uk/ A link to COT, an independent scientific committee that provides advice to the Food Standards Agency, the Department of Health and other government departments and agencies on matters concerning the toxicity of chemicals.</p> <p>Chartered Trading Standards Institute http://www.tradingstandards.uk/ A link to publications, campaigns and information on product recalls.</p>		
Discussion – the need for good practice in laboratory research	<p>When testing products, learners should appreciate the necessity for excellent, and consistent, with set standards, laboratory practice.</p> <p>The international standard of GLP (good laboratory practice) is a quality system used in research labs. It was set up to guarantee the quality, consistency, and reproducibility of data collected through laboratory studies.</p> <p>GLP standards regulate procedures and standards through which chemicals for the pharmaceutical, agriculture, cosmetics, food, and food additives and other industries are tested in the collection of data used to assess consumer health and environment risks. It is a regulatory requirement that:</p> <ul style="list-style-type: none"> • any studies to test health or environmental safety of new chemicals or biological substances must be conducted within the principles of GLP • any test facility that intends to conduct studies must be a member of the UK GLP Compliance monitoring programme, run by the UK GLP Monitoring Authority (UK GLPMA). <p>Information on GLP should be included in learners' manuals.</p> <p>Good laboratory practice (GLP) for safety tests on chemicals Medicines and Healthcare products Regulatory Agency (MHRA) https://www.gov.uk/guidance/good-laboratory-practice-glp-for-safety-tests-on-chemicals An overview of GLP.</p>	1 hour	Unit 2 LO1

SUGGESTED ACTIVITIES

LO No:	2		
LO Title:	Understand how product testing determines the development of consumer products		
Title of suggested activity	Suggested activities	Suggested timings	Also related to
Discussion of product testing	<p>The requirement for product testing should be discussed with learners. This requirement should also be discussed in terms of when this is required in the life cycle of the product, namely:</p> <ul style="list-style-type: none"> • at the formulation stage • at the production stage • as part of quality control and quality assurance • as part of after-sale monitoring of the product. <p>The significance of these should be discussed, principally in terms of ensuring that a product is safe, both in the short- and long-term, is 'fit for purpose' – it is effective and remains effective, its degradability/biodegradability, the product matches company claims and specifications/labelling, and assessing environmental effects.</p> <p>Learners will apply this knowledge and understanding to specific testing techniques in subsequent activities, and it is suggested that work for Learning Outcomes 2, 3 and 4 should be delivered in an integrated way, and culminate in conclusions and evaluations in Learning Outcome 5, so after this initial session, the areas of solvent extraction, titration techniques and chromatographic techniques are grouped together as continuous activities.</p> <p>Learner research is perhaps best approached through the work of consumer forums and the contributions of specific companies to testing of consumer products at various stages, which will give a more specific, rather than generic approach to testing. A number of companies give detailed overviews on the Internet.</p> <p>Nutrition and product formulation The Consumer Goods Forum http://www.consumergoodsforbetterlives.com/nutrition-and-product-formulation/ An excellent overview on product formulation in terms of nutrition.</p> <p>Formula Scan homepage http://www.formulascan.com/index.html A very interesting website providing intellectual property updates based on the most recent data published in the patent literature on consumer products and pharmaceuticals worldwide.</p>	1 hour	Unit 2 LO2

Title of suggested activity	Suggested activities	Suggested timings	Also related to
<p>Discussion of product testing (continued)</p>	<p>From Concept to Consumer: Food Product Development Institute of Food Technologists http://www.ift.org/Knowledge-Center/Learn-About-Food-Science/K12-Outreach/Video-and-Media/From-Concept-to-Consumer.aspx. A 20-minute video, along with a teacher manual and student handouts, on food product development.</p> <p>Formulation Applied Consumer Services http://www.appliedconsumer.com/formulation2.html. An American company certified by the FDA and following GLP practice. A good overview of services related to formulation and 'deformulation' services, which also gives indications of costs.</p> <p>Welcome to Cosmetics Laboratory Limited Cosmetics `lab http://www.cosmeticslab.co.uk/. The homepage to a website that gives an very good overview of the development of a cosmetics product.</p> <p>Consumer Product testing Eurofins Scientific http://www.eurofins.com/consumer-product-testing/. A pan-European consumer product testing company that gives a very good overview of of types of testing of coatings, cosmetics, detergents, household products and hygiene products.</p>		

Title of suggested activity	Suggested activities	Suggested timings	Also related to
<p>Produce a laboratory notebook section on <i>in vitro</i> testing of a consumer product</p>	<p>Across Learning Outcomes 2, 3 and 4, learners will produce a laboratory notebook on the techniques involved in consumer product testing. For each technique, the laboratory notebook will include:</p> <ul style="list-style-type: none"> • a description of the procedure, including management of health and safety • reasons for the selection of each procedure and when it is carried out • an explanation of the effectiveness of each test • a record of data collected, along with calculations and any statistical analyses carried out. <p>Learners' laboratory notebooks will then be used to produce more formal reports on the consumer testing of various products for Learning Outcome 5.</p> <p>The first technique to be investigated is the <i>in vitro</i> testing of products, or potential products. Learners should appreciate the nature of <i>in vitro</i> testing of products and research and report on applications and specific techniques. The use and development of cell and tissue culture systems specific to the product under test should be discussed, along with scientific and technical limitations of <i>in vitro</i> testing</p> <p>The implications for <i>in vitro</i> testing, of a ban on animal testing for all new cosmetics and their ingredients sold in Europe (including if any testing was performed outside Europe) could be discussed. It may be possible to organise a laboratory visit where learners could see procedures first hand.</p> <p>Following on from the first activity suggested for this Learning Outcome, learners should discuss and provide examples of when this testing is required in the life cycle of the product, namely:</p> <ul style="list-style-type: none"> • at the formulation stage • at the production stage • as part of quality control and quality assurance • as part of after-sale monitoring of the product. <p>Guidance on a strategy for genotoxicity testing of chemical substances The Committee on Mutagenicity of Chemicals in Food, Consumer Products and the Environment https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/315800/in_vivo_testing_of_genotoxicity_of_chemicals.pdf</p> <p>An excellent overview of <i>in vitro</i> and <i>in vivo</i> testing.</p> <p>Laboratory Developed Tests US Food and Drug Administration (FDA) http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/InVitroDiagnostics/ucm407296.htm Laboratory-developed testing.</p>	2 hours	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
<p>Produce a laboratory notebook section on <i>in vitro</i> testing of a consumer product (contionued)</p>	<p>Biosciences Cyprotex http://www.cyprotex.com/biosciences A UK company focusing on efficacy screening using cell based assays, for pharmaceutical and biotech, cosmetics/personal care and chemicals industries as well as academia and not-for-profit organisations. There are very good sections on toxicology, and skin and ocular testing.</p> <p>Recent in In vitro Cosmetics & Toiletries http://www.cosmeticsandtoiletries.com/testing/invitro/ A very useful website, bringing together some contemporary research, that will give a good overview of processes involved. The option is available to sign up to a newsletter.</p>		
<p>Produce a laboratory notebook section on <i>in vivo</i> testing of a consumer product</p>	<p>Learners should now investigate <i>in vivo</i> testing of consumer products, compiling the relevant sections of their laboratory notebooks (see previous suggested activity). They should appreciate the nature of <i>in vivo</i> testing of products and its necessity in pharmaceutical preparations. They should research applications and specific techniques and some of the excellent resources given below. It may be possible to organise a laboratory visit where learners could see procedures first hand.</p> <p>There are many scientific, legal, financial and ethical implications of animal testing, and its use, over <i>in vitro</i> testing, must be justified. Learners should consider decisions to be made, including criteria for selection of the species the testing is to be carried out on, dose, route of administration, the length of the study/studies, and the status of the animals concerned, e.g. breeding animals specifically for this purpose, and their fate after the study.</p> <p>Following on from the first activity suggested for this Learning Outcome, learners should discuss when this testing is required in the life cycle of the product (and what research is in the public domain), namely:</p> <ul style="list-style-type: none"> • at the formulation stage • at the production stage • as part of quality control and quality assurance • as part of after-sale monitoring of the product. <p>Their notes will contribute to their laboratory notebooks.</p> <p>Guidance on a strategy for genotoxicity testing of chemical substances The Committee on Mutagenicity of Chemicals in Food, Consumer Products and the Environment https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/315800/in_vivo_testing_of_genotoxicity_of_chemicals.pdf An excellent overview of <i>in vitro</i> and <i>in vivo</i> testing.</p>	2 hours	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
<p>Produce a laboratory notebook section on <i>in vivo</i> testing of a consumer product (continued)</p>	<p>S2(R1) Genotoxicity Testing and Data Interpretation for Pharmaceuticals Intended for Human Use US Food and Drug Administration (FDA) http://www.fda.gov/downloads/Drugs/Guidances/ucm074931.pdf An excellent overview of <i>in vitro</i> and <i>in vivo</i> testing of pharmaceuticals</p> <p>Recent in <i>In vivo</i> Cosmetics & Toiletries http://www.cosmeticsandtoiletries.com/testing/invivo/ A very useful website, bringing together some contemporary research, that will give a good overview of processes involved. The option is available to sign up to a newsletter.</p> <p>Bankim C. Nandy et al (2011) <i>In vitro–In vivo</i> Correlation: Application in pharmaceutical development of various dosages forms, <i>Journal of Chemical and Pharmaceutical Research</i>, 3(5): 550–564 https://www.academia.edu/2216815/In_vitro_In_vivo_Correlation_Application_in_Pharmaceutical_Development_of_Various_Dosages_Forms?auto=download. An interesting article on correlation of <i>in vitro</i> and <i>in vivo</i> testing. Learners would have to set up an http://www.academia.edu account via email, Facebook or Google. This would be invaluable for future use.</p>		
<p>Carrying out titrations</p>	<p>Learners will have carried out acid-base titrations in Unit 2. For Unit 2 Learning Outcome 3, they will undertake a number of acid-base titrations on consumer products, reinforcing these techniques, and at this point, should have discussed what applications titrations might have in product testing.</p> <p>Learners' discussions and investigations of the use of titration techniques should contribute to the compilation of the relevant sections of their laboratory notebooks (see previous suggested activities).</p> <p>As with other techniques used in product testing, notes on when the techniques are carried out should focus on when this testing is required in the life cycle of the product, namely:</p> <ul style="list-style-type: none"> • at the formulation stage • at the production stage • as part of quality control and quality assurance • as part of after-sale monitoring of the product. <p>Acid base titrations Radiometer Analytical SAS http://www.labor-soft.ro/pdf/D41T009.PDF An excellent overview of acid-base titrations on a Romanian analytical company website.</p>	1 hour	Unit 2 LO3

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Extracting and separating ingredients from consumer products	<p>At this stage, learners will gain an overview of the significance of extracting and then separating ingredients from consumer products, using solvent extraction and chromatography, and its significance in quality control – in identifying and quantifying ingredients – over the product lifetime, and trading standards testing.</p> <p>Learners' discussions and investigations of the use of extraction and separation techniques should contribute to the compilation of the relevant sections of their laboratory notebooks.</p> <p>As with other techniques used in product testing, notes on when the techniques are carried out should focus on when this testing is required in the life cycle of the product, namely:</p> <ul style="list-style-type: none"> • at the formulation stage • at the production stage • as part of quality control and quality assurance • as part of after-sale monitoring of the product. <p>Learners will add their discussions to their laboratory notebooks.</p> <p>There are many websites specific to product testing that could form part of learners' analyses. These are two websites on solvent extraction:</p> <p>Extraction of Caffeine Indiana State University, Department of Chemistry and Physics http://carbon.indstate.edu/inlow/LabManuals/Caffeine.pdf Extraction of caffeine from coffee using dichloromethane.</p> <p>Extraction of Caffeine from Tea Leaves Volunteer State Community College http://www2.volstate.edu/CHEM/2010/Labs/Caffeine_Extraction.htm Extraction of caffeine from tea leaves using propanol.</p>	1 hour	Unit 2 LO2

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Evaluating testing methods	<p>Having carried out their research, learners should revisit each testing method and evaluate these from aspects of their being fit for purpose, validity, repeatability and reproducibility. They will adopt a comparative approach in some areas, e.g. <i>in vitro</i> vs <i>in vivo</i> testing.</p> <p>From their research in other activities in this Learning Outcome, learners should appreciate the need for standard testing techniques to ensure validity, repeatability and reproducibility of results. Some of these techniques are laid out in detail in the resources cited. Learners will realise that other factors, not as easy to control, may come into play in instances where biological material is used.</p> <p>Criteria for the effectiveness of the testing procedure:</p> <ul style="list-style-type: none"> • Is the method appropriate in terms of validity? • Will the method lead to the collection of repeatable, reproducible data? • Are the duration and extent of the investigation appropriate? <p>In terms of the product:</p> <ul style="list-style-type: none"> • Does it have a consistent chemical composition? • Are there potential hazards and risks associated with its use, e.g. toxicity, mutagenicity, teratogenicity, microbiological aspects? <p>Learners will add their discussions of evaluation of testing to their laboratory notebooks. It is likely that these evaluations will not be fully complete until the testing has been carried out in Learning Outcomes 3 and 4 and analyses in Learning Outcome 5.</p> <p>There are numerous resources available on scientific methodology.</p>	2 hours	Unit 3 LO7

SUGGESTED ACTIVITIES

LO No:	3		
LO Title:	Be able to use quantitative titration techniques on consumer products		
Title of suggested activity	Suggested activities	Suggested timings	Also related to
Discuss and demonstrate the principles of titration	<p>The activities suggested for Learning Outcomes 3, 4 and 5 could form the basis of learners' reports on the analysis of consumer products. On an interim basis, learners will record procedures, aspects of health and safety and results in a laboratory notebook.</p> <p>Learners will have carried out acid-base titrations in Unit 2. They should now review the principles, i.e. for a known chemical reaction, finding the concentration of an unknown, if its volume that reacts with a measured volume of a standard of known concentration is known.</p> <p>A demonstration of the technique may be the simplest way of recapping the technique of titration.</p> <p>Acid-Base Titrations University of California, Davis LibreTexts Project http://chem.libretexts.org/Textbook_Maps/Analytical_Chemistry_Textbook_Maps/Map%3A_Analytical_Chemistry_2.0_(Harvey)/09_Titrimetric_Methods/9.2%3A_Acid%E2%80%93Base_Titrations An excellent overview of acid-base titrations.</p> <p>Acid-base titrations Radiometer Analytical SAS http://www.labor-soft.ro/pdf/D41T009.PDF An excellent overview of acid-base titrations on a Romanian analytical company website.</p>	1 hour	Unit 2 LO3

Title of suggested activity	Suggested activities	Suggested timings	Also related to
<p>Carry out an acid-base titration</p>	<p>Learners will have carried out at least one acid-base titration in Unit 2. An acid-base titration should now be put into the context of analysing a consumer product(s).</p> <p>One, or a number of, acid-base titration(s) could be done as a practice titration, or as part of a more formal analysis of a consumer product that will go on to be evaluated.</p> <p>Possible acid-base titrations on consumer products might include:</p> <ul style="list-style-type: none"> • alkalinity of bleach • acidity of fruit drinks • acidity of mustards • acidity of milk products • acidity of vinegars • acidity of vegetable oils • carbon dioxide in wine or beer. <p>For each type of titration, in their laboratory notebooks, they should include:</p> <ul style="list-style-type: none"> • a description of the technique used, that could be followed by another user, e.g. a technician • calculations based on data that learners have collected, but which also could be used as examples for others, explaining how the these are carried out • a discussion of when the technique would be used in the product's development, i.e. in its formulation, production, as part of quality control, and/or after-sale monitoring of the product. <p>Acid-Base Titrations University of California, Davis LibreTexts Project http://chem.libretexts.org/Textbook_Maps/Analytical_Chemistry_Textbook_Maps/Map%3A_Analytical_Chemistry_2.0_(Harvey)/09_Titrimetric_Methods/9.2%3A_Acid%E2%80%93Base_Titrations An excellent overview of acid-base titrations.</p> <p>Acid-base titrations Radiometer Analytical SAS http://www.labor-soft.ro/pdf/D41T009.PDF An excellent overview of acid-base titrations on a Romanian analytical company website.</p>	2 hours	Unit 2 LO3

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Carry out a precipitation titration	<p>Learners will have carried out at least one precipitation titration in Unit 3. A precipitation titration should now be put into the context of analysing a consumer product(s).</p> <p>One, or a number of, precipitation titration(s) could be done as a practice titration, or as part of a more formal analysis of a consumer product that will go on to be evaluated.</p> <p>Possible precipitation titrations on consumer products might include:</p> <ul style="list-style-type: none"> • chloride concentration of meat, ham and canned food • artificial seawater for aquaria • salt in butter. <p>Determination of Chloride by Precipitation Titration with Silver Nitrate - Mohr's Method University of Canterbury, Christchurch, New Zealand http://www.outreach.canterbury.ac.nz/chemistry/chloride_mohr.shtml An excellent guide.</p> <p>Precipitation titration SRM University http://www.srmuniv.ac.in/downloads/Precipitation_Titration.pdf An excellent guide.</p> <p>Precipitation titrations Radiometer Analytical SAS http://www.labor-soft.ro/pdf/D41T010.PDF An excellent overview of precipitation titrations on a Romanian analytical company website.</p>	2 hours	Unit 3 LO6

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Carry out a redox titration	<p>Learners will have carried out at least one redox titration in Unit 3. A redox titration should now be put into the context of analysing a consumer product(s).</p> <p>One, or a number of, redox titration(s) could be done as a practice titration, or as part of a more formal analysis of a consumer product that will go on to be evaluated.</p> <p>Redox titrations Radiometer Analytical SAS http://www.labor-soft.ro/pdf/D41T012.PDF An excellent overview of redox titrations on a Romanian analytical company website.</p> <p>Redox Titrations Tutorial Aus-e-Tute http://www.usetute.com.au/redoxitr.html A good overview of redox titrations with an example calculation.</p> <p>Working out mass BBC Bitesize Higher Chemistry http://www.bbc.co.uk/bitesize/higher/chemistry/calculations_3/redox_titr/revision/2/ A good overview of redox titrations with an example calculation.</p>	2 hours	Unit 3 LO6

Title of suggested activity	Suggested activities	Suggested timings	Also related to
<p>Carry out a complexometric titration</p>	<p>Learners will have carried out at least one complexometric titration in Unit 3.</p> <p>Learners could carry out one or more titrations using EDTA – ethylenediaminetetraacetic acid (using old nomenclature). EDTA is a hexadentate ligand, donating six electron pairs to form six dative-covalent bonds and binds strongly with many metal cations Mn^{+}, where n is usually 2 or 3.</p> <p>A complexometric titration should now be put into the context of analysing a consumer product(s).</p> <p>One, or a number of, complexometric titration(s) could be done as a practice titration, or as part of a more formal analysis of a consumer product that will go on to be evaluated. Possible complexometric titrations on consumer products might include:</p> <ul style="list-style-type: none"> • Ca^{2+} in a powdered milk product • Mg^{2+} in Milk of Magnesia. <p>Appendix 1. Information on EDTA structure and function Doc Brown http://www.docbrown.info/page06/Mtestsnotes/ExtraVolCalcs1.htm#1. The excellent Doc Brown website.</p> <p>Complexometric titration Federica Web Learning http://www.federica.unina.it/agraria/analytical-chemistry/complexometric-titration/1/ An easy to assimilate guide to complexometric titrations.</p> <p>Complexometric Titration TutorVista http://chemistry.tutorvista.com/analytical-chemistry/complexometric-titration.html Another good account of the process.</p> <p>Determination of Calcium Ion Concentration University of Canterbury, Christchurch, New Zealand http://www.chemteach.ac.nz/investigations/documents/calcium.pdf An excellent guide.</p> <p>Complexometric titrations Radiometer Analytical SAS http://www.labor-soft.ro/pdf/D41T011.PDF An excellent overview of complexometric titrations on a Romanian analytical company website.</p>	2 hours	Unit 3 LO6

SUGGESTED ACTIVITIES

LO No:	4		
LO Title:	Be able to use extraction and separation techniques on consumer products		
Title of suggested activity	Suggested activities	Suggested timings	Also related to
Extracting product ingredients – discussing the principles of solvent extraction	<p>The activities in Learning Outcomes 3, 4 and 5 will form the basis of learners' reports on the analysis of consumer products. On an interim basis, learners will record procedures, aspects of health and safety and results in a laboratory notebook.</p> <p>In analyses, learners will appreciate that product testing will necessitate the extraction of key ingredients.</p> <p>The principles of solvent extraction should be discussed with learners, demonstrated and learners given the opportunity to investigate the principles practically. These involve simple dissolution techniques, e.g. extraction of a dye from a pharmaceutical, through to the use of two solvents, with the ingredient under investigation partitioning itself between the two solvents. Learners could work through the example of caffeine extraction given in the resource below. Extractions on coffee could be carried out with dichloromethane (methylene dichloride), cyclohexane and methylbenzene (toluene) and yields compared.</p> <p>Extraction of Caffeine Indiana University, Department of Chemistry and Physics http://carbon.indstate.edu/inlow/LabManuals/Caffeine.pdf An excellent presentation on the principles of solvent extraction.</p>	30 minutes	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
<p>Extracting product ingredients</p> 	<p>Learners should have the opportunity to carry out at least two solvent extractions. One should involve the extraction of a dye, e.g. from a pharmaceutical or cosmetic product, and the other should require the partitioning of the ingredients between two solvents.</p> <p>Caffeine is an excellent substance for extraction and analysis as it partitions itself between aqueous and organic solvent layers. Chlorinated hydrocarbons give the highest partition coefficients, but centres may prefer to use alternatives such as propanol. Most of the protocols pertain to extraction of caffeine from coffee or tea, but these could be readily adapted to extraction from high caffeine 'energy drinks'.</p> <p>The extractions should be quantitative, with learners measuring the masses extracted. Values could be compared with product specifications, though it should be borne in mind that the extraction procedure may not be 100% efficient.</p> <p>There is an opportunity to introduce some mathematics whilst evaluating the procedure, calculating efficiency of solvent extraction using a single extraction, or using an identical volume but several aliquots of solvent.</p> <p>Learners should record the activity, and data, in their laboratory notebooks.</p> <p>Extraction of Caffeine Indiana State University, Department of Chemistry and Physics http://carbon.indstate.edu/inlow/LabManuals/Caffeine.pdf Extraction of caffeine from coffee using dichloromethane.</p> <p>Extraction of Caffeine from Tea Leaves Volunteer State Community College http://www2.volstate.edu/CHEM/2010/Labs/Caffeine_Extraction.htm Extraction of caffeine from tea leaves using propanol.</p> <p>Quantitative extraction of caffeine with calculation of extraction efficiency using the partition coefficients of different solvents Beeby, J. (1996) <i>Nuffield Science in Practice GNVQ</i>, Assignments 2. Assignment 37, page 46. Heinemann https://www.stem.org.uk/system/files/elibrary-resources/legacy_files_migrated/11016-Nuffield%20Science%20In%20Practice%20GNVQ%20Science%20Assignments%20%20Advanced.pdf This resource is now out of print but available online at the National STEM Centre. Tutors/learners must register for a password to use the site, but this offers a wealth of resources for applied sciences.</p>	3 hours	

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Separating the components of a product using thin-layer chromatography (TLC)	<p>Learners will be familiar with thin-layer chromatography (TLC) from their work in Unit 2. After a brief recap of principles and procedures, learners should be given the opportunity of carrying out some TLC separations. One could be based on the dyes extracted from the product in the previous suggested activity .</p> <p>Learners should carry out a full risk assessment, record all data (including a scan or photograph of the chromatogram) and calculate R_f values of the components.</p> <p>Thin layer chromatography Clark, J. – Chemguide http://chemguide.co.uk/analysis/chromatography/thinlayer.html An introductory guide to TLC.</p> <p>Thin Layer Chromatography Gung, B., Miami University http://www.users.miamioh.edu/gungbw/CHM254_html/pdfs/TLC_Student.pdf Excellent introduction to TLC with tasks and a challenge relating to an insect repellent.</p> <p>Thin Layer Chromatography University of California, Davis LibreTexts Project http://chem.libretexts.org/Core/Analytical_Chemistry/Lab_Techniques/Thin_Layer_Chromatography An excellent overview of TLC with some chromatograms for illustration.</p>	4 hours	Unit 2 LO2 Unit 3 LO6
Research project on microanalytical techniques	<p>Learners should consider how the microanalytical techniques learnt about in Unit 2 give improved analyses owing to their greater sensitivity. The techniques should include:</p> <ul style="list-style-type: none"> • high-performance liquid chromatography (HPLC) • gas chromatography (GC) • atomic emission spectroscopy-inductively coupled plasma (AES-ICP) • mass spectrometry (MS). <p>Learners' research on these techniques should form part of their evaluation of consumer product testing techniques, with these techniques offering improved analyses. Learners should appreciate that HPLC and GC do not give unequivocal identification, without the use of MS.</p>	1 hour	Unit 2 LO5

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Research project on microanalytical techniques (continued)	<p>Useful resources for this activity include:</p> <p>Gas-Liquid Chromatography; High Performance Liquid Chromatography – HPLC; The Mass Spectrometer Clark, J. – Chemguide http://chemguide.co.uk/analysis/chromatography/gas.html http://chemguide.co.uk/analysis/chromatography/hplc.html http://chemguide.co.uk/analysis/masspec/howitworks.html Very good introductory guides to HPLC and MS.</p> <p>LCGC Chromatography Online http://www.chromatographyonline.com/ Excellent introduction to some contemporary applications of HPLC, GC and MS.</p> <p>Chromatography – Introductory theory Sheffield Hallam University http://teaching.shu.ac.uk/hwb/chemistry/tutorials/chrom/chrom1.htm The principles of chromatography.</p> <p>The Mass Spectrometer Michigan State University http://www2.chemistry.msu.edu/faculty/reusch/VirtTxtJml/Spectrpy/MassSpec/masspec1.htm The principles of MS.</p> <p>Inductively Coupled Plasma-Atomic Emission Spectroscopy - Short Report University of California, Berkeley College of Chemistry https://www.ocf.berkeley.edu/~jmlvll/lab-reports/ICP-AES/ICP-AES.pdf The principles of AES-ICP.</p> <p>Inductively Coupled Plasma Scheeline Group, University of Illinois http://scheeline.scs.uiuc.edu/atomic_spectroscopy/ICP.html The principles of AES-ICP.</p>		

SUGGESTED ACTIVITIES

LO No:	5		
LO Title:	Be able to test the effectiveness of consumer product tests		
Title of suggested activity	Suggested activities	Suggested timings	Also related to
Analysing the results	<p>Learners could now carry out analyses of data generated from the activities undertaken for Learning Outcomes 3 and 4 to produce their consumer product analysis reports.</p> <p>Learners should have recorded procedures, aspects of health and safety, and results in their laboratory notebooks.</p> <p>Results should be used from Learning Outcomes 3 and 4, though it is unlikely that these will cover all aspects of teaching.</p> <p>Appropriate scenarios should therefore be sought to supplement primary data with secondary. Results and analyses should cover:</p> <ul style="list-style-type: none"> • appropriate recording of results, in an appropriate format • appropriate calculations, e.g. means and use of significant figures • experimental uncertainties – calculating uncertainty and percentage uncertainty • graphical analysis – selecting the type of graph (pie charts, bar charts, line graphs, scattergraphs: learners could find secondary data here to cover this range – e.g. scattergraphs of population data on correlation between a health effect and an ingredient in a consumer product) • statistical analyses. <p>Basic statistics can be used to consider the spread of data in sets of learners' results, e.g. standard deviation.</p> <p>The spread of data is important in comparing what appear to be differences in two or more sets of data. Learners could, for instance, use the student's t-test to do this, or ANOVA, for means of several sets of data.</p> <p>   </p> <p>Statistical Hypothesis Testing Explorable https://explorable.com/statistical-hypothesis-testing?qid=1586 Gives a concise overview of some of the principles of statistics.</p>	4 hours	Unit 3 LO1, LO2, LO4, LO7

Title of suggested activity	Suggested activities	Suggested timings	Also related to
Concluding and evaluating	<p>Learners now have to use their results and analyses to look for patterns and trends and draw conclusions, and consider unexpected results, limitations of the analyses. What are the strengths of the analysis, weaknesses, areas for improvement and areas for subsequent research?</p> <p>Various textbooks include sections on drawing conclusions from scientific data.</p> <p>Drawing Conclusions Explorable https://explorable.com/drawing-conclusions A good overview of drawing conclusions in science.</p>	2 hours	Unit 3 LO5, LO7



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