Unit 22: Chemical Laboratory Techniques

Unit code: Y/502/5568

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to give learners many opportunities to prepare, purify and analyse compounds made by reactions and by extraction. There is also a focus on qualitative and quantitative analysis, including analysis of compounds contained within commercial formulations.

Unit introduction

Whether it is in enforcing environmental standards and targets, finding new medicines to combat cancer, designing new materials to replace worn-out knee joints or helping to detect and convict criminals, workers with good chemical laboratory skills are vital. This unit is designed to enable learners to acquire and develop a range of highly sought-after practical skills.

Chemists make new substances by chemical reactions. In purifying and analysing these products, it is essential to work safely, carefully and accurately. Chemists must also be able to interpret and follow instructions and communicate what they have done and found out. Chemists working in industry use many techniques that involve very expensive apparatus. During this unit learners will find out about some of this equipment, and possibly get the chance to use it. However, all chemists started with basic equipment. In using this equipment carefully and safely, learners will develop manipulative skills and find that more sophisticated apparatus requires a similar approach.

During this unit, learners will develop confidence in handling chemicals safely and the ability to set up equipment, monitor and control the reactions that they use to produce compounds. Learners will use a variety of analytical techniques to assess the quality of their products. As they become more experienced, they will refine their practical skills to achieve greater percentage yields and higher purity more quickly. Learners should also improve the reliability of their analytical measurements and observations.

This unit enables learners to consider what it is like to work in a science laboratory. It is suitable for all learners who are interested in a career in science.

Learning outcomes

On completion of this unit a learner should:

1 Be able to prepare substances

2 Be able to measure percentage yield and percentage purity

3 Be able to carry out qualitative analysis of compounds

4 Be able to carry out quantitative analysis of compounds within a matrix.

Unit content

1 Be able to prepare substances

Preparations: one inorganic compound made from a reaction, eg sodium chloride, copper (II) sulphate crystals ($CuSO_4 5H_2O$), magnesium sulphate ($MgSO_4 7H_2O$), silver chloride (AgCl); one organic compound made by a reaction, eg 2,4 dinitrophenylhydrazone derivative of an aldehyde or ketone, paracetamol, acetanilide, ethyl ethanoate, aspirin, cyclohexanone oxime; substance(s) extracted from a natural material, eg a sample of calcium carbonate by re-precipitation from limestone or chalk, salicylic acid from willow bark or oil of wintergreen, plant pigments from leaves, caffeine from tea leaves; substance(s) extracted from a synthetic material, eg plasticisers from PVC clingfilm by reflux with cyclohexane, paracetamol from a tablet, aspirin from a tablet, salt from butter

Preparative techniques: precipitation; evaporation; filtration (gravity and under reduced pressure); recrystallisation; reflux; distillation; solvent extraction, eg separating funnel or Soxhlet extractor; preparative chromatography

2 Be able to measure percentage yield and percentage purity

Estimation of purity: melting point; boiling point (only where a liquid has been prepared); chromatography, eg thin layer chromatography (TLC), paper chromatography, GC, HPLC

Measurement of purity (for at least two of the substances prepared): titration, eg with silver nitrate for sodium chloride, EDTA for copper (II) sulphate or magnesium sulphate; spectroscopy, eg colorimetric measurement for copper (II) sulphate, spectroscopic measurement in comparison with a standard for aspirin or paracetamol, thin layer chromatography or HPLC for aspirin or caffeine in comparison with a standard

Percentage yield: measurement of mass; use of appropriate equation, eg % yield = (actual number of moles/expected number of moles) x 100

Percentage purity: use of appropriate equation, eg % purity = (mass of pure substance present in sample/ mass of sample) x 100

Green chemistry: atom economy of an industrial manufacturing process, eg % atom economy = (molar mass of desired product/molar mass of all reactants) x 100; difference between yield and atom economy, choice of different synthetic pathways to get improved atom economy; combinatorial chemistry

3 Be able to carry out qualitative analysis of compounds

Qualitative analysis of inorganic substances: tests for anions, eg Cl^-, Br^-, I^-, CO_3^{2-}, NO_3^-, SO_4^{2-}, SO_3^{2-}; tests for cations, eg Na^+, K^+, Mg^{2+}, Ca^{2+}, Ba^{2+}, Al^{3+}, Zn^{2+}, Fe^{2+}, Fe^{3+}, Cu^{2+}, Ni^{2+}

Qualitative analysis of organic substances: tests for organic substances, eg alkenes, primary and secondary alcohols, aldehydes, ketones, carboxylic acids, amines, identification of aldehydes and ketones from melting points of derivatives; identification of functional groups from infrared spectra

4 Be able to carry out quantitative analysis of compounds within a matrix

Quantitative analysis – volumetric: preparation of solutions of known concentrations; appropriate acid base and redox titrations to analyse commercially available or natural substances, eg vinegar (acid/base), aspirin (acid/base), hydrogen carbonate in river water (acid/base), hypochlorite bleach (iodine/sodium thiosulphate, redox), copper in digested brass (iodine/sodium thiosulphate, redox), iron supplement tablets (acidified manganate (VII), redox); calculation of concentration mol dm^{-3}, g dm^{-3}, mg dm^{-3} (ppm) as appropriate

Quantitative analysis – spectroscopic: use of a spectroscopic instrument, eg colorimeter, ultraviolet/visible spectrometer, infrared spectrometer

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 follow a range of procedures to obtain substances by reaction and extraction [EP3]	**M1** describe the scientific principles behind the key steps in the preparative methods for substances	**D1** explain how the yield, purity and atom economy of the substances prepared may be affected by changes to the methods used
P2 follow methods to determine % yield, % purity and atom economy of prepared substances [EP3]	**M2** describe the main problems with each of the preparative methods used	
P3 use test-tube reactions and infrared spectroscopy to identify functional group compounds [RL2; CT2,5]	**M3** explain how the test-tube reactions and infrared spectra allowed the functional groups of each substance to be identified	**D2** evaluate whether the qualitative analysis carried out was conclusive
P4 carry out chemical tests to identify inorganic substances [RL2; CT2,5]	**M4** explain the bases of the chemical tests used to identify inorganic substances	
P5 perform quantitative analysis of commercial/natural substances by following given methods. [EP3]	**M5** identify sources of error and uncertainty in the quantitative analyses carried out.	**D3** evaluate the reliability of the analyses of the commercial/ natural compounds.

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key			
	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

This unit should be delivered through a variety of practical projects, of vocational relevance to learners.

Learners have to prepare at least one pure inorganic substance, eg a salt or a complex. Learners often require practice in predicting products from common reactions from Key Stages 3 and 4 such as reactions of acids and precipitation reactions. This activity could support the development of writing word and symbol equations and planning practical work. It is important, in industry, that learners can follow standard methods/protocols and learners should be given a method to follow, even if they have planned aspects themselves. The preparation chosen should be relevant to the course of study where possible, eg preparation of silver chloride for those studying forensic photography.

Learners working on *Unit 16: Chemistry for Biology Technicians* or *Unit 28: Industrial Applications of Organic Chemistry* will be studying functional group reactions. Learners who are not studying these units will need to cover some introductory organic chemistry in order to understand the chemistry involved in preparing a pure organic compound. The compound selected for preparation should be relevant to the course of study. Drugs such as aspirin, antifebrin and paracetamol could be selected for learners studying medical science, for example.

Quality control analysis, analysis of forensic and environmental samples and analysis of medical specimens is often carried out on a matrix. Sometimes other substances present interfere with the analytes and it is necessary to isolate the analyte by an extraction stage. Commercially useful products may be extracted from naturally occurring substances. Commercially useful products are often formulated to be mixtures of other substances. Learners should be given the opportunity to extract a substance from a naturally occurring substance and a substance from a commercially useful product. The compounds should be chosen to allow learners to use as many techniques as possible in the extraction.

For all the preparative work, learners should calculate the % yield obtained and understand the principles of the extraction to work out how yield and purity may be optimised. Learners should discuss potential problems with the methods used.

Test-tube reactions on organic functional group compounds should be carried out to highlight the main chemical properties of the compounds. This could link to the preparation of an organic compound as described previously and enables learners to identify compounds from simple functional group reactions. The main stretches in the infrared of a range of functional group compounds can be measured where the centre has an infrared spectrometer. Alternatively, spectra of these compounds may be downloaded from the internet or copied from books. Learners should recognise the infrared spectra of simple compounds before being presented with spectra from unidentified compounds. Test-tube reactions, eg decolourisation of bromine water, reduction of dichromate (VI), positive reaction with Fehling's solution, reaction with 2,4-dinitrophenylhydrazine and reaction with carbonate, and measurement of pH of solutions of functional group compounds should allow most compounds to be identified. However, there is likely to be some ambiguity in the results. Learners may identify classes of compounds from their infrared spectra and then compare the results from test-tube reactions and from infrared spectroscopy.

Inorganic ions have been identified as part of *Unit 4: Scientific Practical Techniques*. Learners find it difficult to remember tests for ions so additional opportunities can be given to identify inorganic ions. The range of ions may be extended.

Quantitative analysis may be carried out in relation to the substances extracted or prepared. The use of given methods allows learners to follow methods and to work independently. Alternatively, other commercial or natural substances may be analysed. Learners should be encouraged to work out how they will know whether the results from the analysis are correct and what the main sources of error in analysis may be. When calculating concentration it should be acknowledged that although parts per million (ppm) are acceptable, they are not as preferable and specific as others mentioned in the *Unit content*.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction to unit and programme of assignments.
As an introduction, discuss how copper (II) sulphate may be prepared. Follow a given method to make copper (II) sulphate. Measure mass. Carry out an EDTA titration or colorimetric analysis. Discuss the techniques used at each stage. Calculate % yield and % purity. Discuss the factors influencing yield and purity.
Assignment 1 – Preparation of Substances (P1, P2, M1, M2, D1) (Possibly part of P5, M5 and D3 too) Write about each of the five preparations. Include at least one consideration of atom economy.
Preparation 1 – Making Sodium Chloride Discuss how sodium chloride may be prepared. Follow a given method to make sodium chloride. Measure mass. Carry out a silver nitrate titration. Calculate % yield and % purity. Allow learners time to write about the analysis and methods used.
Preparation 2 – Preparation of Antifebrin Prepare antifebrin by a reaction. Compare the melting point with literature value. Calculate % yield. Carry out quantitative ultraviolet analysis, using a pure sample as a standard. Calculate % purity.
Preparation 3 – Preparation of Ethyl Ethanoate Prepare ethyl ethanoate using reflux and distillation. Measure boiling point. Carry out quantitative ultraviolet spectroscopy.
Preparation 4 – Extraction of Paracetamol from a Tablet Prepare paracetamol from a tablet. Calculate percentage yield. Measure melting point and compare the value with a literature value. Comment on purity. Calculate % yield.
Preparation 5 – Extracting Pigment from Leaves Extract pigments from leaves using Soxhlet extraction and rotary evaporation. Carry out thin layer chromatography (TLC). Discuss principles. Calculate % yield.
Assignment 2 – Identification of the Class of Six Unidentified Organic Compounds Using Test-tube Reactions and Infrared Perform typical reactions for alkenes, alcohols (primary and secondary), aldehydes, ketones, carboxylic acids and amines. Study infrared spectra and identify the key features of functional groups. Present learners with unknown organic compounds. Learners carry out test-tube reactions. Learners identify compounds on the basis of test-tube reactions and then use infrared spectroscopy to confirm deductions. **(P3, M3 and D2 (part))**
Assignment 3 – Identification of Inorganic Substances Carry out test-tube reactions involving anions and cations. Identify unknown inorganic substances. Discuss the ambiguities in the test and the need to add reagents in particular orders. Explain how the tests work. **(P4, M4 and D2 (part))**

Topic and suggested assignments/activities and/assessment
Carry out titrations on commercial substances, eg oxidise iron (II) to iron (III) using manganate (VII); sodium hydroxide titration of diluted vinegar; sodium thiosulphate/iodide titration of hypochlorite; digest brass and measure copper concentration using a colorimeter.
Assignment 4 – Analysis of the Salt Content of a Low Fat Spread (P5, M5, D3) **Assignment 5 – Comparison of the Vitamin C Content of Fresh and Frozen Broccoli (P5, M5, D3)** Write-ups to include factors affecting accuracy in the analysis.
Review of unit and programme of assignments.

Assessment

To achieve P1, learners must carry out at least four preparations correctly, following given methods. Since analysts in industry must follow standard methods, it is important that learners follow the given method exactly. This could be confirmed by use of a suitable checklist by the tutor. The method must exist in written form. Learners should follow the written method where possible. Learners with literacy problems may follow verbal instructions, corresponding to the standard method. Learners should prepare an inorganic compound and an organic compound by reaction. They should isolate two compounds, one from a natural source and one from a synthetic source.

To achieve P2, learners should follow instructions to determine the % yield and % purity of the substances prepared and isolated and the atom economy of the two substances prepared by reaction. There is an opportunity to achieve P5, M4 and D3 as part of these exercises.

Learners may achieve M1 by describing the principles involved in the four preparations. This may be as part of a lab report or as part of a pro forma. Learners should identify and describe the difficulties associated with the given methods in order to achieve M2.

To achieve D1, learners should give specific examples of how the yield, purity and atom economy of the substances prepared may be increased/decreased by straightforward changes to the method. Tutors should select the substance for preparation carefully to allow atom economy to be considered. To alter atom economy, another preparative route must be available. Although standard laboratory reports are desirable, a variety of other presentational methods may be used, eg presentation software, photo-stories, detailed posters.

For P3, learners should be presented with six liquids from each of six different class of organic compound. Since many of the tests are inconclusive, it is necessary to give most learners a detailed method sheet which leads pass only learners towards the correct conclusions. Learners may carry out infrared analysis of the six liquids or be presented with the infrared spectra. This should enable learners to check the deductions made on the basis of chemical tests and should provide fairly conclusive evidence for the classification of the compounds.

For M3, learners must explain the logic which lead them to assign the compounds to particular classes and justify the reliability of the decisions about classes in order to partly achieve D2. This should correspond with the requirements of the scenario but if the criteria are met without satisfying the requirements of the scenario, the learner must be credited with the criteria.

To achieve P4, learners must carry out a range of test-tube reactions identify inorganic substances. This exercise should be additional to the similar one in *Unit 4: Scientific Practical Techniques*. It need not be more difficult but, ideally, more tests should be involved. For example, transition metal cations and aluminium ions may be identified by test-tube reactions, involving sodium hydroxide, ammonia and hydrochloric acid.

To achieve M4, learners should be able to explain how the anion and cation tests work, using equations where appropriate.

To achieve D2 fully, an evaluation of whether the results are conclusive should be provided as part of a lab report, in a format in line with the scenario or in any other suitable format.

If learners have not carried out analysis of commercial and natural substances in conjunction with P1, P2, M1, M2 and D1, they may conduct additional analysis and present results in a suitable format to achieve P5. Learners should identify specific and realistic sources of error in the analysis to achieve M5. General statements like 'operator error' or 'error reading equipment' are not sufficient. To achieve D3 learners must make realistic judgements about the reliability of the results of the analysis. Learners could, for example, discuss the number of significant figures in each of the measurements and the number of significant figures to which the result may be quoted. They could compare their own results with those of other learners and draw appropriate conclusions

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1, M2, D1 (part of P5, M5 and D3)	Making Sodium Chloride	As a waste management technician, you have been called in to check the labelling on two large tanks, believed to be 0.1 mol dm^{-3} NaOH and HCl. By following the given method, prove that the tanks are correctly labelled.	Follow the given method. Complete a pro forma or write a lab report.
P1, P2, M1, M2, D1 (part of P5, M5 and D3)	Preparation of Antifebrin and Ethyl Ethanoate	You work for a pharmaceutical company and have been asked to carry out the preparation of antifebrin and ethyl ethanoate in the lab so that you can help to explain some of the problems on the plant.	Follow the method. Complete pro forma or write laboratory report.
P1, P2, M1, M2, D1 (part of P5, M5 and D3)	Extracting Pigment from Leaves	You are a research and development technician, working for a company trying to optimise solvent extraction for one of its preparative processes.	Follow the method. Complete pro forma or write laboratory report.
P1, P2, M1, M2, D1 (part of P5, M5 and D3)	Extraction and Analysis of Paracetamol from Tablets	You are a quality control technician for a pharmaceutical company.	Follow the method. Complete pro forma or write laboratory report.
P3, M3 D2 (part)	Identification of the Class of Six Unidentified Organic Compounds Using Test-tube Reactions and Infrared	As a journalist for a magazine for crime scene investigators, write an article which explains how useful simple chemical tests can be in identifying colourless organic liquids found at crime scenes.	Identify six classes of compounds and write a report, explaining the selection of functional group. Evaluate whether the results obtained are conclusive.

Criteria covered	Assignment title	Scenario	Assessment method
P4, M4 D2 (part)	Identification of Inorganic Substances	You are a technician employed by a waste management company. You make the initial visits to sites and identify unlabelled inorganic chemicals, known to be of relatively low hazard, so that these chemicals may be disposed of safely.	Devise and carry out a plan for the identification of unidentified inorganic compounds. Explain how the tests work and evaluate whether the results obtained are conclusive.
P5, M5 D3 (part)	Analysis of the Salt Content of a Low Fat Spread	You are an analyst, working for a company which is responsible for correct nutritional labelling of foods.	Follow the given method for determination of salt content by silver nitrate titration of the chloride. Explain how the analysis may be made more accurate and evaluate the certainty to which the result has been found.
P5, M4 D3 (part)	Comparison of the Vitamin C Content of Fresh and Frozen Broccoli	You are a journalist, working for a Sunday newspaper magazine which has a weekly feature on nutrition.	Follow the given method to find the vitamin C content of fresh and frozen broccoli. Explain the factors which affect the accuracy of the result and evaluate the reliability of the result.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the *BTEC Applied Science sector* suite. This unit has particular links with the units shown below in the BTEC National in Applied Science suite of qualifications:

Level 1	Level 2	Level 3
	Chemistry and Our Earth	Scientific Practical Techniques
	Applications of Chemical Substances	Chemistry for Biology Technicians
	Chemical Analysis and Detection	Practical Chemical Analysis
		Industrial Applications of Organic Chemistry

Essential resources

Learners require access to a laboratory which allows organic syntheses, inorganic syntheses and extractions to take place. This will usually require use of isomantles, a steam bath, hotplates, sinks, a fume cupboard and vacuum filtration. There should be access to instrumental techniques and computers.

Employer engagement and vocational contexts

Where possible, learners should visit chemical process industry organisations or have visits from industrial speakers in order to relate preparations carried out in the laboratory to the local economy. Learners could observe or learn about analysis of products and raw materials. Visits to laboratories analysing environmental samples, water or food would also be of benefit. Speakers with experience of forensic analysis may explain how analytes may be extracted in suitable contexts.

Indicative reading for learners

Textbooks

Clark J – *Calculations in AS/A Level Chemistry* (Longman, 2000) ISBN 978058241 1272

Ellis F – *Paracetamol – A Curriculum Resource* (Royal Society of Chemistry, 2002) ISBN 9780854043750

Faust C B – *Modern Chemical Techniques* (The Royal Society of Chemistry, 1995) ISBN 97818703431 90

Fifield F W and Kealey D – *Principles and Practice of Analytical Chemistry, 5th Edition* (Wiley-Blackwell, 2000) ISBN 9780632053841

Hill G and Holman J – *Chemistry in Context* (Nelson Thornes, 2004) ISBN 9780174481911

Hill G and Holman J – *Chemistry in Context: Laboratory Manual and Student Guide* (Nelson Thornes, 2001) ISBN 9780174483076

Hunt A – *Advanced Level Practical Work for Chemistry* (Hodder Murray, 2004) ISBN 9780340886724

Levinson R – *More Modern Chemical Techniques* (The Royal Society of Chemistry, 2001) ISBN 9780854049295

Mueller-Harvey I and Baker R M – *Chemical Analysis in the Laboratory, A Basic Guide* (Royal Society of Chemistry, 2002) ISBN 9780854046461

Ramsden E N – *Calculations for A-Level Chemistry* (Nelson Thornes, 2001) ISBN 9780748758395

Journals

Chemistry Review

Chemical Science (RSC)

Chemistry World (RSC)

Journal of Chemical Education

Websites

www.rsc.org/education/teachers/learnnet/pdf/LearnNet/rsc/Aspirin_full.pdf	A curriculum resource on aspirin
www.virtlab.com/main.aspx	A virtual laboratory

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Creative thinkers	[CT2,5] using test-tube reactions and infrared spectroscopy to identify organic functional group compounds carrying out chemical tests to identify inorganic substances
Reflective learners	[RL2] setting goals for their development and work when using test-tube reactions and infrared spectroscopy to identify organic functional group compounds carrying out chemical tests to identify inorganic substances
Effective participators	[EP3] following a range of techniques to obtain substances by reaction and extraction; following methods to determine percentage yield, percentage purity and atom economy of prepared substances; performing quantitative analysis of commercial/natural substances by following given methods.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	[IE1] finding out about the principles of operation of techniques
Creative thinkers	[CT3] annotating pictures to produce a presentation of a technique, such as the Soxhlet extraction of pigments from leaves; planning how an inorganic salt may be obtained
Reflective learners	[RL5] considering whether alterations to the techniques would bring better results
Team workers	[TW1,2] pooling results from a group experiment, like Soxhlet extraction using different solvents
Self-managers	[SM1] carrying out techniques with the minimum of assistance from tutors [SM2,3] meeting deadlines for assignments.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	using the centre's computer system effectively and independently to find out about techniques and present results
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	using appropriate software to create a diary, mind-map or word document for planning
Manage information storage to enable efficient retrieval	saving experimental data and data about techniques into appropriate files and folders
Follow and understand the need for safety and security practices	keeping food and drink away from computers not using someone else's login explaining how safety is addressed in the context of the tasks explaining why the IT usage policy forbids certain actions
Troubleshoot	carrying out checks to identify the source of a problem encountered, eg missing file of work
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	obtaining data from experiments, books, staff and the internet in order to meet the needs of the assignment tasks
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	obtaining information from the internet and shared files on the computer and selecting the parts of the information relevant to the tasks, eg finding out the principles of operation of techniques
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	collecting data on extraction, analysis, principles of operation of techniques and digital photographs of equipment. Extraction/ analysis data will involve numbers. Principles of operation of techniques will involve texts. Data on the appearance of extracts may be collated in a table
Bring together information to suit content and purpose	ensuring all the above data is in one file, ready to be edited
Present information in ways that are fit for purpose and audience	presenting data and information in line with the requirement of the assignment. For example, if a presentation, using appropriate software, about a technique is required, tables must not contain too much information and annotated pictures are effective
Evaluate the selection and use of ICT tools and facilities used to present information	writing a document considering how the information could have been presented better
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	emailing material, including attached files, to tutors and classmates using contact lists storing messages and replies in appropriate folders and being observed doing the above

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	understanding how yield and purity may be calculated in a range of contexts. Understanding the need to calculate concentrations for particular applications
Identify the situation or problem and the mathematical methods needed to tackle it	identifying the mathematical operations and the appropriate data needed for yield and purity calculations recognising the need to calculate numbers of moles assessing accuracy by considering the class results as a whole and performing simple statistical tests
Select and apply a range of skills to find solutions	choosing to calculate quantities like mean, median and modal class in comparing class results calculating yield and purity calculating number of moles or mass expected and number of moles or mass actually made
Use appropriate checking procedures and evaluate their effectiveness at each stage	calculating from mass to number of moles and number of moles to mass using spreadsheets to check calculations writing about effectiveness of checking procedures
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	writing laboratory reports and other documents such as an annotated presentation document in relation to the extraction, eg of plant pigments identifying and including the relevant mathematical data
Draw conclusions and provide mathematical justifications	drawing conclusions from results and estimating how reliable the results are considering numbers of significant figures
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	discussing how an inorganic salt may be prepared presenting the results of the extraction experiments, eg for plant pigments to small groups of classmates
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	reading information on how techniques operate
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	writing laboratory reports or other documents as required by the assignment briefs.