VCE Chemistry: Sample teaching plan

Sample course outline – VCE Chemistry Unit 4: How are carbon-based compounds designed for purpose?

**Note:** This is a sample guide only and indicates one way to present the content from the *VCE Chemistry Study Design*. VCE units are designed based on a minimum of 50 hours of class time; this sample teaching plan is based on 3 hours per week over 19 weeks and includes activities covering the eight scientific methodologies. Teachers are advised to consider their own contexts in developing learning activities: Which local issues lend themselves to debate and investigation? Which experiments can students complete within the resource limitations of their learning environments? Which local fieldwork sites and chemistry-based facilities would support learning in the topic area? Which chemical industries would be appropriate for site visits?

| **Week** | **Area of study** | **Key knowledge** | **Learning activities**  | **Science skills focus** | **Assessment tasks** |
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| **1** | ***Area of Study 1:******How are organic compounds categorised and synthesised?*** | **Structure, nomenclature and properties of organic compounds** (carbon atom characteristics; formulas and skeletal structures; IUPAC nomenclature; trends in physical properties) | * *Modelling*: Construct models or other representations of the structures of hydrocarbons, haloalkanes, alcohols, carboxylic acids and primary amines, primary amides, aldehydes and ketones, non-branched esters, including isomers
* *Classification and identification*: Classify a range of primary, secondary and tertiary alcohols by testing with acidified potassium dichromate solution
* *Experiment*: Determine experimentally the boiling point of isopropyl alcohol and the melting point of powdered acetamide; conduct a safety audit prior to undertaking the investigations
* *Experiment*: Determine experimentally the trend in boiling points of a series of organic compounds; conduct a safety audit prior to undertaking the investigation
* *Classification and identification*: Prepare a summary sheet or flow chart outlining the IUPAC rules for naming organic compounds
 | * use appropriate chemical terminology, representations and conventions
* organise and present data in useful and meaningful ways, including flow charts, tables, line graphs
* demonstrate safe laboratory practices when planning and conducting investigations by using risk assessments that are informed by safety data sheets (SDS), and accounting for risks
* discuss relevant chemical information, ideas, concepts, theories and models and the connections between them
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| **2** |  |
| **3** |  |
| **4** | **Reactions of organic compounds** (organic reactions and pathways, % yield; atom economy; sustainability of the production of chemicals) | * *Classification and identification*: Design and annotate flow charts to represent reaction pathways for: the synthesis of primary haloalkanes and primary alcohols by substitution; addition reactions of alkenes; esterification; ester hydrolysis; synthesis of primary amines and carboxylic acids; transesterification to produce biodiesel; hydrolysis of proteins, carbohydrate and fats; and condensation polymerisation reactions to produce biomolecules
* *Experiment*: Design and perform test-tube scale [ester synthesis](https://edu.rsc.org/experiments/making-esters-from-alcohols-and-acids/1743.article) from a variety of alcohols and carboxylic acids
* *Experiment*: Measure the change in pH as the enzyme urease (sourced from ground whole soya beans) hydrolyses urea (carbonyl diamide) in solution
* *Experiment*: Prepare a sample of nylon in the laboratory and extract a protein from food (for example, casein from milk); compare the structure of nylon with that of a protein
* *Product development:* Make [small-scale biodiesel](https://www.uwa.edu.au/study/-/media/Faculties/Science/Docs/Activity-Making-biodiesel.pdf) using cooking oils or grease as a starting reactant
* *Case study*: Research a selected industrial process or product synthesis and summarise the operating conditions, including temperature and pressure conditions and the use of catalysts; calculate atom economies of products; investigate the use of green and safer reagents (for example, the use of acidified potassium dichromate for oxidation of alcohols can be replaced by Fenton’s reagent)
 | * demonstrate safe laboratory practices when planning and conducting investigations by using risk assessments that are informed by safety data sheets (SDS), and accounting for risks
* apply relevant occupational health and safety guidelines while undertaking practical investigations
* organise and present data in useful and meaningful ways, including flow charts, tables, line graphs
* apply sustainability concepts to analyse and evaluate responses to chemistry-based scenarios, case studies, issues and challenges
* use appropriate chemical terminology, representations and conventions
* critically evaluate and interpret a range of scientific and media texts (including journal articles, mass media communications and opinions in the public domain), processes, claims and conclusions related to chemistry by considering the quality of available evidence
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| **5** |  |
| **6** | **SAC task 3: Analysis and evaluation of a chemical innovation, research study, case study, socio-scientific issue, or media communication (including reference to sustainability)** (50 minutes):Use a provided media communication or case study about a more sustainable production process for a selected organic compound to analyse and evaluate impacts for society and the contribution to the United Nations Sustainable Development Goals, including a discussion of atom economy, use of renewable feedstocks, catalysis, the design of safer chemicals and/or the transition to a circular economy. |
| **7** | ***Area of Study 2:*** ***How are organic compounds analysed and used?*** | **Laboratory analysis of organic compounds** (qualitative tests; melting point determination; distillation; iodine test for degree of unsaturation; redox titrations) | * *Experiment*: Perform [qualitative tests](https://edu.rsc.org/practical/qualitative-tests-for-organic-functional-groups-practical-videos-16-18-students/4014327.article) for carbon–carbon double bonds, hydroxyl and carboxyl functional groups
* *Experiment*: Perform a titration to determine the degree of saturation of fats and oils
* *Experiment*: Perform redox titrations to determine the quantities of Vitamin C in different fruits
* *Case study*: Analyse and evaluate a case study of the analysis of an unknown compound (for example, food poisoning, drug detection, metal contamination)
 | * demonstrate safe laboratory practices when planning and conducting investigations
* record and summarise both qualitative and quantitative data
* systematically generate and record primary data
* process quantitative data using appropriate mathematical relationships and units
* repeat experiments to evaluate the precision of data
* use reasoning to construct scientific arguments, and to draw and justify conclusions
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| **8** |  |
| **9** | **Instrumental analysis of organic compounds** (mass spectrometry; infrared spectroscopy; 13C-NMR; 1H-NMR; HPLC; determination of structures of organic compounds using a combination of instruments; laboratory and instrumental analysis applications) | * *Interpretation*: Interpret simple mass spectrographs of atoms and molecules, simple IR spectrographs, and some simple proton and carbon-13 NMR spectrographs to determine the composition and structure of an unknown compound
* *Application*: Predict the spectra of given organic compounds
* *Modelling:* Create an animation or other visual representation to illustrate how an HPLC column works at the particle level
* *Fieldwork:* Arrange a site tour of an analytical laboratory to observe chemical instrumentation at work; process sample data
* *Analysis*: Compare the spectra from instrumental analysis of different brands of commercial tea tree oils to identify common functional groups or spectral regions
 | * process quantitative data using appropriate mathematical relationships and units
* evaluate data to determine the degree to which the evidence supports the aim of the investigation
* use appropriate chemical terminology, representations and conventions, including standard abbreviations
* use reasoning to construct scientific arguments, and to draw and justify conclusions consistent with evidence and relevant to the question under investigation
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| **10** |  |
| **11** | **SAC task 4: Analysis and evaluation of primary and/or secondary data, including identified assumptions or data limitations, and conclusions** (50 minutes):Use provided spectra and data related to a case study involving an organic contaminant in a food sample to identify the contaminant, including a discussion of the limitations of the provided data. |
| **12** | **Medicinal chemistry** (solvent extraction and distillation; functional groups of medicines; isomers and chiral centres; enzymes; competitive enzyme inhibition) | * *Discussion*: Suggest ways that the active ingredients of known [bush medicines](https://www.wettropics.gov.au/site/user-assets/docs/bushmedicine.pdf) can be extracted and purified
* *Experiment*: [Extract the essential oils (for instance from lemons)](https://www.beyondbenign.org/bbdocs/curriculum/high-school/Essential_Oil_Extraction_Using_Liquid_CO2.docx) using steam distillation
* *Classification and identification*: Use a range of examples of medicinal compounds to identify structure and functional groups, including isomers and chiral centres which may be attributed to the bioactivity of the compounds
* *Modelling*: Model the ‘lock-and-key’ mechanism of enzyme action
* *Modelling*: Use a data table of amino acids to model the molecular structures of 2-amino acids, their condensation reactions and peptide links
* *Experiment*: Investigate the effect of temperature, pH and catalyst concentration on reactions catalysed by enzymes
* *Case study*: Discuss the action of penicillin as a competitive enzyme inhibitor
* *Literature review*: Research the production, chemical structure and use of a selected natural product or synthetic medicine (for example, citridiol insect repellent from lemon eucalyptus tree, a range of antibiotics, and cisplatin for cancer treatment)
 | * identify, research and construct aims and questions for investigation
* discuss relevant chemical information, ideas, concepts, theories and models and the connections between them
* analyse and explain how models and theories are used to organise and understand observed phenomena and concepts related to chemistry, identifying limitations of selected models/theories
* critically evaluate and interpret a range of scientific and media texts, processes, claims and conclusions related to chemistry by considering the quality of available evidence
* use reasoning to construct scientific arguments, and to draw and justify conclusions consistent with evidence and relevant to the question under investigation
* identify, describe and explain the limitations of conclusions, including identification of further evidence required
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| **13** |  |
| **14** |  |
| **15** | ***Area of Study 3:******How is scientific inquiry used to investigate the sustainable production of energy and/or materials?*** | **Investigation design** (concepts; methodology and method; data generation; measurement terms; health and safety)**Scientific evidence** (nature of evidence; data organisation, analysis and evaluation; logbooks; limitations of investigation methodology, data and/or analysis)**Science communication** (conventions; ways of presenting findings; key findings and research implications) | * Investigation design brainstorming - three options offered to students: ‘biofuels’, ‘galvanic cell function’, or ‘plant compound extraction and distillation’ as an extension of prior investigations
* Discuss investigation requirements and timelines with students, including investigation templates and assessment rubrics
* Students undertake background research related to their investigation out-of-class, with logbook entries and authentication record
* Discuss Anthony Hewish’s quote that: ‘I believe scientists have a duty to share the excitement and pleasure of their work with the general public, and I enjoy the challenge of presenting difficult ideas in an understandable way.’
* Student investigation: negotiation; confirmation of methodology and method; materials and equipment preparation
* Students undertake investigation (individually or in pairs, but reports completed individually) and record results in logbooks
* Poster evaluation: strengths/ weaknesses/ opportunities/ threats of provided examples
* Students analyse investigation results
* Students produce poster of their investigation, using a scientific poster template
 | * identify, research and construct aims and questions for investigation
* formulate hypotheses to focus investigations
* determine appropriate investigation methodology
* design and conduct investigations; select and use methods appropriate to the selected investigation methodology, taking into account potential sources of error and causes of uncertainty; determine the type and amount of qualitative and/or quantitative data to be generated
* record and summarise quantitative data
* organise and present data in useful and meaningful ways
* use reasoning to construct scientific arguments, and to draw and justify conclusions consistent with evidence and relevant to the question under investigation
* use clear, coherent and concise expression to communicate for specific purposes in appropriate scientific genres
* acknowledge sources of information and assistance, and use standard scientific referencing conventions
 | **Investigation design** (30 minutes): Present an individual investigation plan, including materials, procedure, and safety requirements |
| **16** | **Data analysis and evaluation** (40 minutes): Students have logbooks returned after data recording, and analyse and evaluate their primary data  |
| **17** | **Scientific poster** (40 minutes):Students use information in logbooks and prior data analysis and evaluation to complete poster template |
| **18** | **Unit revision** |
| **19** |