VCE Chemistry: Sample teaching plan

Sample course outline – VCE Chemistry Unit 2: How do chemical reactions shape the natural world?

**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 do chemicals interact with water?*** | **Water as a unique chemical** (3 states of water; hydrogen bonding consequences; latent heat of vaporisation) | * *Literature review*: Summarise online data from world maps showing freshwater distribution and the proportion of available drinking water
* *Experiment*: Determine the effect of temperature on the density of water
* *Modelling*: Produce an animation to illustrate why ice is less dense than liquid water
* *Experiment*: Use a Bunsen burner, paper cup, and balloon to investigate the thermal properties of water
 | * identify independent, dependent and controlled variables in experiments
* predict possible outcomes of investigations
* organise and present data in useful and meaningful ways, including schematic diagrams, flow charts, tables, bar charts, line graphs
* collate secondary data appropriate to the investigation, including use of databases and reputable online data sources
 | **Multimodal presentation** (10 minutes): Present a case for society to prioritise action for the conservation of a selected endangered element |
| **2** | **Acid-base (proton transfer) reactions** (Bronsted-Lowry theory; balanced ionic and full equations; strong and weak acids and bases; concentrated and dilute acids and bases; neutralisation; pH; indicators; applications in society) | * *Classification and identification*: Perform experiments to differentiate between strong and weak acids on the basis of conductivity, pH and rate of reaction with magnesium
* *Product development*: Work in groups to create a pH indicator chart using natural indicators
* *Experiment*: Use [red cabbage pH indicator](https://edu.rsc.org/experiments/making-a-ph-indicator-using-red-cabbage/422.article) to test sample solutions and compare the results with litmus paper or other indicators. Collate class results and discuss the terms ‘accuracy’, ‘precision’, repeatability’, ‘reproducibility’ and ‘resolution’ in terms of the data
* *Classification and identification*: Identify possible components in [antacids](https://iffgd.org/manage-your-health/diet-and-treatments/antacids/) and summarise their advantages and disadvantages. Examine the labels of different antacids (both liquid and tablet forms) and compare the list of ingredients and possible side effects. Suggest a procedure to compare the effectiveness of different antacids
* *Experiment*: Design an investigation to test the effects of solutions of different pH on the mass of calcium carbonate dissolved; relate findings to shell growth in marine invertebrates
 | * identify independent, dependent and controlled variables in experiments
* predict possible outcomes of investigations
* 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
* organise and present data in useful and meaningful ways, including schematic diagrams, flow charts, tables, bar charts, line graphs
* distinguish between opinion, anecdote and evidence, and between scientific and non-scientific ideas
* evaluate data to determine the degree to which the evidence supports or refutes the initial prediction or hypothesis
* use appropriate chemical terminology, representations and conventions, including standard abbreviations, graphing conventions, units of measurement and significant figures
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| **3** |  |
| **4** | **Media response or case study** (20 minutes): Analyse and evaluate the chemistry involved in an application of acid-base chemistry in society. |
| **5** | **Redox (electron transfer) reactions** (oxidising and reducing agents; balanced half and overall redox equations; reactivity series of metals; applications in society) | * *Experiment*: Perform experiments to determine the order of metals in a reactivity series; compare predictions with results; write balanced redox reactions including states; annotate equations to identify the direction of electron flow, oxidising agents, reducing agents, and conjugate redox pairs
* *Experiment*: Test the rate of corrosion of iron nails that are uncoated and coated with different materials
* *Fieldwork*: Observe corrosion, and corrosion-prevention measures, in built-up areas in your neighbourhood
 | * identify, research and construct aims and questions for investigation
* organise and present data in useful and meaningful ways, including schematic diagrams, flow charts, tables, bar charts, line graphs
* use appropriate chemical terminology, representations and conventions, including standard abbreviations, graphing conventions, algebraic equations, units of measurement and significant figures
* discuss relevant chemical information, ideas, concepts, theories and models and the connections between them
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| **6** | **Test** (15 minutes): Write balanced half and overall redox reactions for provided reactions. |

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| **7** | ***Area of Study 2:******How are chemicals measured and analysed?*** | **Measuring solubility and concentration** (solution concentration units; solubility tables and graphs; effects of temperature on solubility; precipitation reactions) | * *Discussion*: Explore factors that make water safe to drink; who determines what makes water ‘safe’ to drink?
* *Experiment*: Formulate hypotheses, design and perform experiments and report on a chosen research question related to saturated and unsaturated solutions
* *Experiment*: Prepare precipitates representing football club colours
* *Experiment*: Use solubility rules to predict the outcomes of precipitation reactions and experimentally test the predictions; write ‘full’ and ionic equations for precipitation reactions that occur
* *Experiment*: Design a procedure to identify an unknown salt dissolved in a water sample
* *Classification and identification*: Collect, individually, an empty package of processed food that contains salt or sugar; calculate total amount of salt or sugar for the product contained in the package; produce a class display to show increasing salt or sugar content for different food products
* *Fieldwork*: Visit a water treatment plant and summarise processes in a flowchart
 | * formulate hypotheses to focus investigations
* predict possible outcomes of investigations
* record and summarise both qualitative and quantitative data, including use of a logbook as an authentication of generated or collated data
* organise and present data in useful and meaningful ways, including schematic diagrams, flow charts, tables, bar charts, line graphs
* process quantitative data using appropriate mathematical relationships and units, including calculations of ratios, percentages
* use appropriate numbers of significant figures in calculations
* 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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| **8** | **Data analysis and evaluation** (15 minutes): Plot provided solubility data and interpret results. |
| **9** | **Analysis for acids and bases** (volume-volume stoichiometry; volumetric analysis) | * *Product development*: Make [sherbet](https://blog.doublehelix.csiro.au/infinitely-scaling-sherbet-recipe/) to investigate an acid-base reaction
* Perform dilutions of different solutions and calculate quantities at each dilution stage
* Prepare a standard solution of anhydrous sodium carbonate and use it to standardise a solution of hydrochloric acid
* *Experiment*: Perform an acid-base titration and use volume–volume stoichiometry to calculate the concentration of an acid or base in a water sample
* *Experiment*: Investigate the acid content in different soft drinks by using a titration procedure
* *Product development*: Formulate an effective antacid to neutralise a given volume of acid, trialling different proportions of common active ingredients found in commercial antacids
* *Experiment*: Investigate the effect of acid rain on the growth of seedlings or leaves by simulating acid rain
* *Literature review*: Research the issue of acid sulfate soils
 | * process quantitative data using appropriate mathematical relationships and units, including calculations of ratios, percentages, percentage change and mean
* use appropriate numbers of significant figures in calculations
* plot graphs involving two variables that show linear and non-linear relationships
* identify and analyse experimental data qualitatively, handling, where appropriate, concepts of: accuracy, precision, repeatability, reproducibility, resolution, and validity of measurements; and errors (random and systematic)
* identify outliers, and contradictory, provisional or incomplete data
* repeat experiments to evaluate the precision of data
* evaluate investigation methods and suggest ways to improve precision, and to reduce the likelihood of errors
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| **10** | **Practical test** (30 minutes for titration; 25 minutes for calculations and response to questions): Perform an acid-base titration (instructions provided in lesson prior to assessment); record results in logbook; use data to calculate an unknown concentration; results compared with accurate concentrate; discussion of accuracy, precision, resolution, and repeatability; discussion of the comparison between actual concentration (provided by the teacher) and student-calculated concentration. |
| **11** | **Measuring gases** (gases contributing to natural and enhanced greenhouse effects; ideal gas equation; gas stoichiometry; molar volume; molar mass) | * *Modelling*: Design a flow chart or other representations to show unit conversions for, and relationships between pressure, volume and temperature of gases
* Simulation: Use the [Keeling Curve](https://keelingcurve.ucsd.edu/) to explore changes in carbon dioxide levels in Earth’s atmosphere over time
* *Simulation*: Use [an interactive applet](https://kcvs.ca/details.html?key=irWindows) to investigate how the global warming potential (GWP) of greenhouse gases is related to the infrared portion of the electromagnetic spectrum
* *Experiment*: Use a gas syringe to collect and measure the gas evolved in a chemical reaction; plot your results as a volume-time graph
* *Case study*: Investigate the basic chemical principles of recent innovative techniques being trialled to directly remove CO2 from the atmosphere
 | * organise and present data in useful and meaningful ways, including schematic diagrams, flow charts, tables, bar charts, line graphs
* plot graphs involving two variables that show linear and non-linear relationships
* 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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| **12** | **Test** (25 minutes): Perform calculations related to gas stoichiometry: molar gas volume and *pV* = *nRT.* |

| **Week** | **Area of study** | **Key knowledge** | **Learning activities**  | **Science skills focus** | **Assessment tasks** |
| --- | --- | --- | --- | --- | --- |
| **13** |  | **Analysis for salts** (sources of salts in water or soil; quantitative analysis of salts) | * *Discussion*: Discuss the rationale for why what is considered ‘safe’ drinking water varies for different chemical pollutants
* *Debate*: Would you drink recycled water?
* *Data analysis*: Use secondary colorimetry data to construct a calibration curve and determine the concentration of an ingredient in a consumer product
* *Experiment*: Perform an instrumental analysis of a coloured species in solution; for example, compare the phosphate content of various fertilisers or washing powders; investigate why phosphates pose problems in waterways and how these problems are resolved
* *Case study*: Refer to the Australian Government Initiative ‘[Water Quality Australia](https://www.waterquality.gov.au/issues/salinity)’ and discuss why salinity is an issue for the quality of water or soil
 | * systematically generate and record primary data, and collate secondary data, appropriate to the investigation, including use of databases and reputable online data sources
* organise and present data in useful and meaningful ways, including schematic diagrams, flow charts, tables, bar charts, line graphs and calibration curves
* plot graphs involving two variables that show linear and non-linear relationships
* apply sustainability concepts (green chemistry principles, development goals and the transition from a linear towards a circular economy) to analyse and evaluate responses to chemistry-based scenarios, case studies, issues and challenges
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| **14** | **Data analysis** (20 minutes): Analyse and evaluate data from a colorimetry experiment, including calibration curve construction and interpretation. |
| **15** | ***Area of Study 3:******How do quantitative scientific investigations develop our understanding of chemical reactions?*** | **Investigation design** (concepts; methodology; data generation; measurement terms; health and safety)**Scientific evidence** (definitions; observation and investigation; data organisation, analysis and evaluation; logbooks; limitations of experiments)**Science communication** (conventions; ways of presenting findings; research implications) | * Discuss the importance of developing investigable questions for scientific investigation considering Albert Einstein’s quote that: ‘The important thing is not to stop questioning’, Robert Half’s quote that ‘Asking the right questions takes as much skill as giving the right answers’ and Nancy Willard’s quote that ‘Sometimes questions are more important than the answers’
* Discuss how the UN Sustainable Development Goals relate to gases, acid-base reactions, redox reactions and water analysis
* Brainstorm possible investigation questions (such as those in the online VCAA Unit 2 Area of Study 3 Teaching and Learning activities) and organise students into pairs to develop an investigation question of interest
* Discuss investigation requirements and timelines with students, including templates and assessment rubrics and/or marking schemes
* Negotiate and confirm scope of student investigations: methodology and method; materials and equipment; risk assessment
* Organise students to undertake investigations and to record results in their logbooks
* Evaluate the strengths/ weaknesses/ opportunities/ threats of provided scientific poster examples
* Discuss the characteristics of effective multimodal communications
* Students analyse their investigation results: limitations of conclusions; possible further investigations
* Students produce a poster to communicate their investigation findings
 | * 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, including consideration of sampling technique and size, equipment and procedures, 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 or collated
* work independently and collaboratively as appropriate and within identified research constraints, adapting or extending processes as required and recording such modifications in a logbook
* record and summarise both qualitative and 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 to specific audiences and for specific purposes in appropriate scientific genres
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| **16** |  |
| **17** | **Multimodal presentation of the findings of a student-designed scientific investigation**: 1. Scientific poster construction (electronic) – 50 minutes
2. Oral presentation of investigation findings supported by the scientific poster – 5 minutes
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| **18** | **Unit revision** |
| **19** |