# Sample Unit: Chemistry – Year 12

***Sample for implementation for Year 12 from Term 4, 2018***

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| **Unit title** | Module 6 –Acid/Base Reactions | **Duration** | 40 hours including 15 hours for Depth Study |
| **Unit description** | **Content focus**  Students analyse how and why the definitions of both an acid and a base have changed over time, and how the current definitions characterise the many chemical reactions of acids. Acids react in particular ways to a variety of substances. These reactions follow a pattern that students identify and explore in detail.  Acids and bases, and their reactions, are used extensively in everyday life and are central to the functioning of the human body. The chemistry of acids and bases also contributes to industrial contexts and the environment. Therefore, it is essential that the degree of acidity in these situations is continually monitored. By investigating the qualitative and quantitative properties of acids and bases, students learn to appreciate the importance of factors, such as pH and indicators.  **Module context**  Students will use the skills they have developed in Module 5, through the study of equilibrium reactions, to apply their knowledge to the study of acids and bases, as fundamental chemicals encountered in their everyday lives. These two modules will form the basis of the Depth Study and will enable students to investigate the application of the chemical principles encountered. Teachers will use specific and authentic contexts to enhance the learning for their students.  **Working Scientifically**  In this module, students focus on developing questions and testing hypotheses through designing, evaluating and conducting investigations to process and analyse data from acid/base reactions. Students will be provided with opportunities to engage with all the Working Scientifically skills throughout the course. | | |
| **Outcomes**  A student:   * develops and evaluates questions and hypotheses for scientific investigation CH11/12-1 * designs and evaluates investigations in order to obtain primary and secondary data and information CH11/12-2 * conducts investigations to collect valid and reliable primary and secondary data and information CH11/12-3 * analyses and evaluates primary and secondary data and information CH11/12-5 * communicates scientific understanding using suitable language and terminology for a specific audience or purpose CH11/12-7 * describes, explains and quantitatively analyses acids and bases using contemporary models CH12-13 | | | |
| **Resources**  Risk assessments associated with each practical investigation  MSDS sheets  **Support websites**   * <http://www.chemtutor.com/> * <http://www.chemguide.co.uk/> * <https://www.khanacademy.org/science/chemistry/acids-and-bases-topic> * <http://www.sciencegeek.net/Chemistry/index.shtml> | | **Formal assessment**   1. Students will be formally assessed on their skills in volumetric analysis during a practical task. 2. The Depth Study will be commenced during Module 6, and may include material from Module 5 on Equilibrium Reactions. This task involves a practical investigation requiring the application of Working Scientifically skills. It may include a field component. | |
| **Topics**   1. Properties of Acids and Bases 2. Using Brønsted – Lowry Theory 3. Quantitative Analysis | | **Inquiry questions**   1. What is an acid and what is a base? 2. What is the role of water in solutions of acids and bases? 3. How are solutions of acids and bases analysed? | |
| **Working Scientifically**  **W/S – Questioning and Predicting – CH11/12-1**  **A student develops and evaluates questions and hypotheses for scientific investigation**  Students:   * develop and evaluate inquiry questions and hypotheses to identify a concept that can be investigated scientifically, involving primary and secondary data (ACSCH001, ACSCH061, ACSCH096)   **W/S – Planning Investigations – CH11/12-2**  **A student designs and evaluates investigations in order to obtain primary and secondary data and information**  Students:   * assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning an investigation (ACSCH031, ACSCH097) * justify and evaluate the use of variables and experimental controls to ensure that a valid procedure is developed that allows for the reliable collection of data (ACSCH002) * evaluate and modify an investigation in response to new evidence   **W/S – Conducting Investigations – CH11/12-3**  **A student conducts investigations to collect valid and reliable primary and secondary data and information**  Students:   * employ and evaluate safe work practices and manage risks (ACSCH031) * use appropriate technologies to ensure and evaluate accuracy * select and extract information from a wide range of reliable secondary sources and acknowledge them using an accepted referencing style  W/S – Analysing Data and Information – CH11/12-5 **A student analyses and evaluates primary and secondary data and information**  Students:   * derive trends, patterns and relationships in data and information * assess error, uncertainty and limitations in data (ACSCH004, ACSCH005, ACSCH033, ACSCH099) * assess the relevance, accuracy, validity and reliability of primary and secondary data and suggest improvements to investigations (ACSCH005) | | **Depth study**  The Depth Study will be introduced at the beginning of the Module and will provide students with the opportunity to further investigate any area of interest they encounter after studying both equilibrium reactions and specific acid/base reactions. Possible ideas could include, but are not limited to:   * Natural indicators, including their stability, Ka values and end point range * The amount of nitrogen in fertilisers, using back titration * The effect of temperature on the vitamin C content in red pepper juice * The effect of increased carbon dioxide on the acidification of salt water * The effect of temperature on the pH of ascorbic acid solution * Factors affecting the action of buffer solutions * The role of the stabiliser, cyanuric acid, in preventing chlorine loss in swimming pools * The effect of sunlight on the chlorine levels in swimming pool * Factors affecting the sulphite content of wine * Comparing titration curves for different combinations of strong and weak acids and bases * Factors affecting the alcohol content of wine * Does the type of acid present in the fruit affect the amount of alcohol in the wine? * Factors affecting the action of antacid tablets * Use of plant saps to neutralise ant stings * Use of clays to neutralise stomach acid * Use of plant saps to neutralise bluebottle stings   It is anticipated that students would spend a total of 15 hours in class time on the Depth Study.  NB: Outcomes CH11/12-1 and CH11/12-7 plus two other skills outcomes and a knowledge outcome must be assessed if the depth study is to be used as a formal assessment task. | |

| **Properties of acids and bases** | | |
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| **Inquiry question:** What is an acid and what is a base? | | |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| **Students:**   * investigate the correct IUPAC nomenclature and properties of common inorganic acids and bases (ACSCH067) | **1. Pre-test using** [crossword](http://www.whenwecrosswords.com/crossword/acids_and_bases/17942/crossword.jsp) **or** [Kahoot game](https://getkahoot.com/how-it-works)   * Brainstorm to check student knowledge and understanding from prior learning. Review names of common inorganic and organic acids and bases, for example: * hydrochloric acid * sulphuric acid * nitric acid * carbonic acid * methanoic acid * ethanoic acid (vinegar) * 2-hydroxypropane-1,2,3-tricarboxylic acid (citric acid) * sodium hydroxide * calcium hydroxide * sodium hydrogen carbonate * ammonia (azane) * others as appropriate * Students should consider the use of commercial chemical indicators to distinguish between acids and bases in the above investigations. Use familiar indicators such as universal indicator, litmus, phenolphthalein, bromothymol blue and methyl orange. | <http://www.whenwecrosswords.com/crossword/acids_and_bases/17942/crossword.jsp>  <https://getkahoot.com/how-it-works> |
| **Students:**   * predict the products of acid reactions and write balanced equations to represent:  Information and communication technology capability icon * acids and bases * acids and carbonates * acids and metals (ACSCH067) | **2. Practical investigation of the properties of acid and bases**   * Students develop an inquiry question and plan an investigation to consider the properties of common acids and bases. Inorganic and organic acids from the list above may be used, with the following reactions to be considered: * acids plus metals (include metals such as Mg, Zn, Pb) * acids plus carbonates (include collection and identification of the gas produced when acids react with CaCO3) * acids plus bases   **W/S – Questioning and Predicting – CH11/12-1**  **W/S – Planning Investigations – CH11/12-2**  **W/S – Conducting Investigations – CH11/12-3** W/S – Analysing Data and Information – CH11/12-5 |  |
| **Students:**   * conduct an investigation to demonstrate the preparation and use of indicators as illustrators of the characteristics and properties of acids and bases and their reversible reactions (ACSCH101) | **3. Practical investigation of the production, properties and use of indicators**   * Students develop an inquiry question, plan and conduct an investigation to extract the juice from red cabbage or any other suitable plant, including beetroot, tea and a variety of flower petals to test the ability to illustrate the properties of acids and bases. Students should compare these colour changes with those of the commercial indicators, including measuring the pH of soils, swimming pools and monitoring chemical waste in the photographic industry.   **W/S – Questioning and Predicting – CH11/12-1**  **W/S – Planning Investigations – CH11/12-2**  **W/S – Conducting Investigations – CH11/12-3** W/S – Analysing Data and Information – CH11/12-5  * Students view the [Natural Indicators](https://www.youtube.com/watch?v=vFjK8Tt-z8g)) multimedia presentation to undertake the following: * a class discussion reviewing reversibility of reactions. Consider the reversibility of reactions involving chemical indicators and the relationship between the acid-form and base-form of these indicators * research some examples about the use of chemical indicators in everyday life. | Natural Indicators  [*https://www.youtube.com/watch?v=vFjK8Tt-z8g*](https://www.youtube.com/watch?v=vFjK8Tt-z8g)*)* |
| **Students:**   * Investigate applications of neutralisation reactions in everyday life and industrial processes | **4. Neutralisation reactions**   * Research applications of neutralisation reactions in everyday life and industry, including but not limited to: * brushing teeth * taking antacids * treating acidic industrial effluents * treating bee and wasp stings * maintaining correct soil pH levels * preventing coagulation of latex * using shampoo to wash our hair. |  |
| * Conduct a practical investigation to measure the enthalpy of neutralisation (ACSCH093) | * Review enthalpy changes and Hess’s Law from Module 4. * Students develop an inquiry question and plan an investigation to measure the enthalpy of neutralisation to produce valid and reliable results. Computer-based technologies may be used. Ensure that two different acids and bases are used, of comparable strengths, and review the significance of the theoretical value for ΔH = - ­56 kJmol-1 (approximately) |  |
| **Students:**   * explore the changes in definitions and models of an acid and a base over time to explain the limitations of each model, including but not limited to: * Arrhenius’ theory * Brønsted–Lowry Theory (ACSCH064, ACSCH067)  Information and communication technology capability icon | **5. Theories of acids and bases**   * Research and class discussion on definitions and models of acids and bases, in an attempt to explain the properties of each. Students should consider Arrhenius and Brønsted–Lowry theory, considering the former as a subset of the latter.   **W/S – Analysing Data and Information – CH11/12-5**  **Teacher demonstration** – use a combustion tube to show the reaction between two cotton wool balls soaked in ammonia solution and concentrated hydrochloric acid. This could be used to show that water is not needed for an acid/base reaction to occur, and hence suggest that ‘superiority’ of Brønsted–Lowry Theory over that of Arrhenius.  A detailed explanation of the relationship of the Brønsted–Lowry Theory to that of Arrhenius is provided in Chemguide:<http://www.chemguide.co.uk/physical/acidbaseeqia/theories.html> | What is the Bronsted-Lowry Theory?  <https://www.youtube.com/watch?v=ZiokqP0aZ1E> |

| **Using Brønsted–Lowry Theory** | | |
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| **Inquiry question:** What is the role of water in solutions of acids and bases? | | |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| **Students:**   * conduct a practical investigation to measure the pH of a range of acids and bases | **1. Practical investigation measuring the pH of a range of acids and bases**   * Students develop an inquiry question and plan an investigation to measure the pH of a range of common substances, using indicators and digital technologies as appropriate. A comparison of results obtained using indicators with digital technologies could prove useful in considering accuracy of measurements and validity of data.   **W/S – Questioning and Predicting – CH11/12-1**  **W/S – Planning Investigations – CH11/12-2**  **W/S – Conducting Investigations – CH11/12-3**  **W/S – Analysing Data and Information – CH11/12-5** |  |
| **Students:**   * calculate pH, pOH, hydrogen ion concentration ([H+]) and hydroxide ion concentration ([OH–]) for a range of solutions (ACSCH102)  Information and communication technology capability icon Numeracy icon | **2. The meaning of pH**   * Teacher demonstration showing the effect of dilution on pH of a strong acid, such as HCl. Use a data logger to record the pH of 0.1M, 0.01M, 0.001M and 0.0001M HCl, to demonstrate that a ten-fold change in concentration corresponds to a change of one pH unit. * Discuss the self-ionisation of water, reviewing the equilibrium constant Kw * Students process information to calculate pH, pOH, hydrogen ion concentration ([H+]) and hydroxide ion concentration ([OH–]) for a range of solutions, using the following: * pH = -log[H+] * pOH = -log[OH-] * pH + pOH = 14 | Calculating pH, pOH, [H+], [H3O+], [OH-] of Acids and Bases <https://www.youtube.com/watch?v=UiK37I159fc> |
|  | Ensure that students are familiar with the use of calculators and other digital technologies and consider significant figures in presenting final answers.  View the [multimedia review of using calculators in pH calculations](https://www.youtube.com/watch?v=UiK37I159fc) |
| **Students:**   * conduct an investigation to demonstrate the use of pH to indicate the differences between the strength of acids and bases (ACSCH102) | **3. Strong and weak acids**   * Students plan an investigation to measure the pH of identical concentrations of strong and weak acids.   **W/S – Questioning and Predicting – CH11/12-1**  **W/S – Planning Investigations – CH11/12-2**  **W/S – Conducting Investigations – CH11/12-3**  **W/S – Analysing Data and Information – CH11/12-5**   * Students describe the difference between a strong and weak acid in terms of an equilibrium between the intact model and its ions. * Students analyse the pH of equimolar solutions of a variety of common acids and identify common acids as strong or weak according to the equilibrium model. |  |
| **Students:**   * construct models and/or animations to communicate the differences between strong, weak, concentrated and dilute acids and bases (ACSCH099)  Information and communication technology capability icon | * Students use diagrams, ionic equations and molecular model kits to explain the terms ‘ionisation’, ‘strong’, ‘weak’, ‘concentrated’ and ‘dissociation’ as applied to acids and bases. * Students identify conjugate acid-base pairs for a variety of strong and weak acids. |  |
| **Students:**   * write ionic equations to represent the dissociation of acids and bases in water, conjugate acid/base pairs in solution and amphiprotic nature of some salts, for example: * sodium hydrogen carbonate * potassium hydrogen sulphate | **4. Amphiprotism**   * Students write equations to describe the amphiprotic nature of salts such as NaHCO3 and K2HPO4 or KH2PO4 |  |
| **Students:**   * calculate the pH of the resultant solution when solutions of acids and/or bases are diluted or mixed  Information and communication technology capability icon Numeracy icon | **5. pH of resultant solutions**   * Students calculate the pH of the resultant solution when solutions of acids and/or bases are diluted or mixed. |  |

| **Quantitative Analysis** | | |
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| **Inquiry question:** How are solutions of acids and bases analysed? | | |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| **Students:**   * conduct practical investigations to analyse the concentration of an unknown acid or base by titration ICTN | **1. The principles and practice of volumetric analysis**   * Review the learning from Module 2 relating to concentration and molarity principles and calculations * Students identify the specific glassware used in volumetric analysis * Students investigate and identify some important properties of a primary standard * Students prepare a standard solution of known concentration, using an acidic and/or basic primary standard, using the following procedural steps: * preparing and weighing a suitable solid * dissolving the solid and transferring the solution to a volumetric flask * adding distilled water correctly to the graduation mark   **W/S – Questioning and Predicting – CH11/12-1**  **W/S – Planning Investigations – CH11/12-2**  **W/S – Conducting Investigations – CH11/12-3**  **W/S – Analysing Data and Information – CH11/12-5**   * Students conduct a practical investigation to analyse the concentration of an unknown acid or base using titration, using the following procedural steps: * rinsing the conical flask, pipette and burette with the correct liquids/solutions * transferring the standard solution into the conical flask correctly * utilising a suitable indicator, given the predicted pH at the equivalence point of the titration * calculating the concentration of the unknown acid or base   **W/S – Questioning and Predicting – CH11/12-1**  **W/S – Planning Investigations – CH11/12-2**  **W/S – Conducting investigations – CH11/12-3**  **W/S – Analysing Data and Information – CH11/12-5** |  |
|  | View the [multimedia presentation on titration technique](https://www.youtube.com/watch?v=sFpFCPTDv2w)  *This activity would be suitable as a formal practical assessment task, given an unknown concentration of an acid or base.* | Titration techniques  <https://www.youtube.com/watch?v=sFpFCPTDv2w> |
| **Students:**   * investigate titration curves and conductivity graphs to analyse data to indicate characteristic reaction profiles, for example:  Information and communication technology capability icon * strong acid/strong base * strong acid/weak base * weak acid/strong base (ACSCH080, ACSCH102) * model neutralisation of strong and weak acids and bases using a variety of media  Information and communication technology capability icon | **2. Analysing titration curves**   * Students explain the characteristic shape of a titration curve and conductivity graph produced when the following are reacted: * strong acid/strong base * strong acid/weak base * weak acid/strong base   Students view the [Chemguide](http://www.chemguide.co.uk/physical/acidbaseeqia/phcurves.html)multimedia presentation. Students use diagrams, computer simulations and molecular model kits to model neutralisation of strong and weak acids and bases using a variety of media. | Chemguide - pH titration curves  <http://www.chemguide.co.uk/physical/acidbaseeqia/phcurves.html>  Understanding an acid base titration curve  <https://www.youtube.com/watch?v=YPM-bbvasC4> |
| **Students:**   * calculate and apply the dissociation constant (*Ka*) and *pKa* (*pKa = -log10 (Ka)*) to determine the difference between strong and weak acids (ACSCH098)  Information and communication technology capability icon Numeracy icon | **3. Acid-base equilibrium**   * Students conduct a practical investigation to determine the acid dissociation constant for ethanoic acid.   **W/S – Questioning and Predicting – CH11/12-1**  **W/S – Planning Investigations – CH11/12-2**  **W/S – Conducting Investigations – CH11/12-3**  **W/S – Analysing Data and Information – CH11/12-5**   * Students process information to calculate Ka and pKa for both strong and weak acid and explain how this can be used as a means of differentiation. |  |
| **Students:**   * explore acid/base analysis techniques that are applied: * in industries * by Aboriginal and Torres Strait Islander Peoples Aboriginal and Torres Strait Islander histories and cultures icon * using digital probes and instruments  Information and communication technology capability icon | **4. Acid-base analysis**   * Students research the use of acid-base analysis in the following industries: * Pharmaceuticals (in quality control) * the food industry (concentration of acids in wine, fruit juice and vinegar) * the mining industry (concentrations of certain metals in ore deposits)   **W/S – Analysing Data and Information – CH11/12-5**   * Aboriginal and Torres Strait Islander Peoples have an extensive knowledge of naturally occurring acids and bases, including sources and uses. * Students research the knowledge and use of acid/base properties of food and materials by Aboriginal and Torres Strait Islander Peoples and present their findings to the class. Students also include reference to cultural ownership and protection of such knowledge (ie Indigenous Intellectual and Cultural Property). * Use the following as possible investigations for acid/base analysis: * Comparing native fruit acid levels against ripeness * The neutralisation of ant stings with plant saps * Using clays to neutralise stomach acid * Using plant saps to neutralise bluebottle stings * Understanding of vitamin levels in plant materials * Using flower colour to identify soil pH levels * Analysing pH levels of various clays used for ochres * Analysing minerals and clays used as antacids * Comparing taste and pH levels of native fruits * Comparing pH levels of differently coloured foliage of the pig-face plant * Comparing the vitamin C (ascorbic acid) levels of native Australian fruits to Australian farmed oranges and lemons.   *This activity could form the basis of a Depth Study.*   * Students research a variety of wet and dry chemical analysis, using digital probes and instruments; these could include gas chromatography, spectroscopy and microscopy. | Chemical analysis by acid-base titration  <http://chem.lapeer.org/Chem2Docs/AcidBaseTitration.html>  Wet Tropics Management Authority 2002. *Bush medicine plants facts sheet*  <http://www.wettropics.gov.au/site/user-assets/docs/bushmedicine.pdf>.  ABC Science 2009. *Rainforest fruit power*  <http://www.abc.net.au/science/articles/2009/04/30/2557398.htm> |
| **Students:**   * conduct a chemical analysis of a common household substance for its acidity or basicity (ACSCH080)  Information and communication technology capability icon Numeracy icon , for example: * soft drink * wine * juice * medicine   **This activity could form the basis of a Depth Study** | **5. Chemical analysis of a common household substance**   * Students develop an inquiry question and plan and conduct an investigation to analyse the acidity/basicity of a common household substance. These could include: * analysis of carbon dioxide/phosphoric acid content in a soft drink * analysis of ethanol content in white wine; or ethanoic acid content in vinegar * analysis of citric acid content in orange juice * analysis of aspirin tablets using a back titration; or investigating some cures for indigestion   **W/S – Questioning and Predicting – CH11/12-1**  **W/S – Planning Investigations – CH11/12-2**  **W/S – Conducting Investigations – CH11/12-3**  **W/S – Analysing Data and Information – CH11/12-5**  *This activity could form the basis of a Depth Study.* |  |
| **Students:**   * conduct a practical investigation to prepare a buffer and demonstrate its properties (ACSCH080)  Information and communication technology capability icon Numeracy icon * describe the importance of buffers in natural systems (ACSCH098, ACSCH102) | **6. Investigating buffers**   * Students plan and conduct an investigation, using exhaled carbon dioxide as an introduced acid, to investigate the properties of the acetic acid/acetate ion buffer.   **W/S – Questioning and Predicting – CH11/12-1**  **W/S – Planning Investigations – CH11/12-2**  **W/S – Conducting Investigations – CH11/12-3**  **W/S – Analysing Data and Information – CH11/12-5**   * Students carry out secondary-sourced research to qualitatively describe the effect of buffers with reference to a specific example in a natural system.   **W/S – Analysing Data and Information – CH11/12-5** |  |

**Reflection and Evaluation**

# TEACHER: CLASS:

**DATE UNIT COMMENCED: DATE UNIT CONCLUDED:**

* **Variations to program:** (List additional resources and outline alternative strategies used)
* **The most effective teaching/learning strategies and resources in this unit were:** (Please nominate 3 at least)
* **Less effective teaching strategies and resources for this unit were:** (Please nominate 2 at least)

**TEACHER’S SIGNATURE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_­­­­­\_\_\_\_\_**

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