# Sample Unit – Chemistry – Year 11

***Sample for implementation for Year 11 from 2018***

***This unit of work compliments the published assessment schedule sample D***

| **Unit title** | **Module 2: Introduction to Quantitative Chemistry**  **Context: In chemical technology, it’s what you don’t see that counts!** | **Duration** | *30 hours (including 7 hours of depth study)* |
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| **Unit description** | Content focus Students are introduced to the quantitative nature of chemistry. Chemists must be able to quantify reactions in order to make predictions about yields and communicate to specific audiences for specific purposes using the appropriate nomenclature, genres and modes unique to the discipline. Using the mole concept, students will have the opportunity to select and use appropriate mathematical representations to solve problems, make predictions and calculate the mass of reactants and products, whether solid, liquid or gas. Students further develop their understanding of the universal language of chemistry. They are introduced to the idea that science is a global enterprise that relies on clear communication, international conventions, peer review and reproducibility. Module context **In Chemical Technology, it’s what you don’t see that counts!**  Understanding quantitative relationships of reactants and products in chemical reactions is fundamental to chemical technology. The industrial productions of fertiliser, the combustion of fuels, the treatment of water, the manufacture of cosmetics are some examples. In each case, it is necessary to understand reacting quantities and proportions of all reactants – solids, liquids and gases – in order to understand the technology used to monitor and control the products and processes. Working Scientifically In this module, students focus on designing and evaluating investigations that enable them to obtain quantitative data to help them solve problems related to quantitative chemistry. Students should be provided with opportunities to engage with all the Working Scientifically skills throughout the course. | | |
| **Outcomes**  A student:   * 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 * selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media CH11/12-4 * solves scientific problems using primary and secondary data, critical thinking skills and scientific processes CH11/12-6 * describe, apply and quantitatively analyse the mole concept and stoichiometric relationships CH11-9 | | | |
| **Resources**  Risk assessments associated with each practical investigation  MSDS sheets  30 hours of scheduled coursework  Access to ICT  Depth study – 7 hours  Practical assessment task related to Depth Study.  <http://www.chem1.com/acad/webtext/intro/int-4.html>  The Amazing Mole  <http://www.vea.com.au/secondary-school/the-amazing-mole.html>  The Mole Concept  <https://www.youtube.com/watch?v=wORiAOnvw8g>  <https://molesandstoichiometry.wikispaces.com/file/view/chalk.doc>  Gas Laws  <http://www.grc.nasa.gov/WWW/K-12/airplane/glussac.html>  <http://www.grc.nasa.gov/WWW/K-12/airplane/boyle.html> | | **Formal assessment**  **Task 2: Practical** | |
| **Topics**   1. Chemical Reactions and Stoichiometry 2. Mole Concept 3. Concentration and Molarity 4. Gas Laws | | **Inquiry questions**   1. What happens in chemical reactions? 2. How are measurements made in chemistry? 3. How are chemicals in solutions measured? 4. How does the Ideal Gas Law relate to all other Gas Laws? | |
| **Working Scientifically skills**  **Designs and evaluates investigations in order to obtain primary and secondary data and information CH11/12-2**   * 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   **Conducts investigations to collect valid and reliable primary and secondary data and information CH11/12-3**   * 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   **Selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media CH11/12-4**   * select qualitative and quantitative data and information and represent them using a range of formats, digital technologies and appropriate media (ACSCH004, ACSCH007, ACSCH064, ACSCH101) * apply quantitative processes where appropriate * evaluate and improve the quality of data   **Solves scientific problems using primary and secondary data, critical thinking skills and scientific processes CH11/12-6**   * use modelling (including mathematical examples) to explain phenomena, make predictions and solve problems using evidence from primary and secondary sources (ACSCH006, ACSCH010) * use scientific evidence and critical thinking skills to solve problems | | **Depth Study**  The depth study will be introduced at the beginning of the module within the module context of chemical technology and applications of analytical chemistry. It will take seven hours of class time and some independent student time to develop.  Students will maintain a process diary to substantiate their Depth Study learning.  Students will then take responsibility for their own learning by preparing for a practical assessment in class after Module 3 Chemical Reactions have been investigated. | |

| **Topic: Chemical Reactions and Stoichiometry** | | |
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| **Inquiry question: What happens in chemical reactions?** | | |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
|  | **Module Introduction:**  Hours: 1  **Context: In Chemical Technology, it’s what you don’t see that counts!**  Think, Pair, Share  Recall: What is technology?  How are new substances formed during chemical reactions?  Think: 1. What are some chemical substances that are made using technology?  2. Why would quality control in these technologies be important?  Students form pair and share ideas  Students develop conclusions about the need for quantitative chemistry and analytical chemists.  Students understand that these conclusions will lead to an in-depth study using quantitative chemistry and the products of chemical reactions. |  |
| Students:  ● conduct practical investigations to observe and measure the quantitative relationships of chemical reactions, including but not limited to:   * masses of solids and/or liquids in chemical reactions * volumes of gases in chemical reactions (ACSCH046) * relate stoichiometry to the law of conservation of mass in chemical reactions by investigating: * balancing chemical equations (ACSCH039) * solving problems regarding mass changes in chemical reactions (ACSCH046) | **Chemical Reactions and Stoichiometry**  **Inquiry question: What happens in chemical reactions?**  Hours: 8  Depth Study - Background Information (3 hours)  **Investigation Mass Changes in Chemical Reactions** **1:**  Recall from Stage 5 that precipitation reactions and other important chemical reactions that occur in non-living systems involve energy transfer.  The precipitation reaction between sodium chloride and silver nitrate is used to observe and measure the quantitative relationships of chemical reactions. (ACSCH046)  For this investigation students use a working scientifically scaffold to devise the following (emphasise in this investigation the bold items with respect to the Working Scientifically skills):   * Problem – *does mass change during a chemical reaction?* * Aim– *to observe mass before and after a reaction.* * Hypothesis – *the mass will not change because atoms are just rearranged in a chemical reaction.* * Equipment – *beakers, silver nitrate and sodium chloride, electronic balance* * **Risk assessment** – *skin and eye irritants; appropriate disposal of waste* ***CH11/12-2a, 2b*** * **Procedure** – *10mL each solution, weigh mass before and after, compare masses.* ***CH11/12-3a, 3b*** * Results – *record masses, photos before and after*   **Conclusion** – *mass before and after were the same, law of conservation of mass, a precipitate of silver chloride was produced, word equation. Validity? Reliability?* ***CH11/12-4a, 4b***  Write a balanced chemical equation and net ionic equation for the reaction between sodium chloride and silver nitrate. (ACSCH039) |  |
|  | Define stoichiometry.  Complete a worksheet of problems regarding mass changes in chemical reactions and write balanced chemical equations for each problem. (ACSCH046) (ACSCH039) ***CH11/12-6a, 6b***  [Worksheet](http://www.chem1.com/acad/webtext/intro/int-4.html) | <http://www.chem1.com/acad/webtext/intro/int-4.html> |
| (Cont) | **Investigation Mass Changes in Chemical Reactions** **2:**  In small groups, use their previous scientific evidence and critical thinking to design an investigation related to conservation of mass. Using vinegar, baking soda and a balloon. CH11/12-2 CH11/12-3 CH11/12-4 ***CH11/12-6b***  Quantitatively determine the volume of carbon dioxide gas produced in the chemical reaction (ACSCH046) ***CH11/12-4b***  *Opportunity for peer assessment –Assessment for/as Learning.*  *Teacher feedback on student practical reports and problems worksheet. Assessment for Learning.*  **Reflection**  **“What happens in chemical reactions? What can’t be seen that counts?”**  *Opportunity for self-assessment – Assessment as Learning*  Begin a process diary about quantitative chemistry and the work of analytical chemists in chemical technology. |  |

| **Topic: Mole Concept** | | |
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| **Inquiry question:**  **How are measurements made in chemistry?** | | |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
| Students:   * conduct a practical investigation to demonstrate and calculate the molar mass (mass of one mole) of: * an element * a compound (ACSCH046) | **Mole Concept**  **Inquiry question: How are measurements made in chemistry?**  Hours: 8  Through class discussion students brainstorm how to work out how many molecules of oxygen should react with a small piece of magnesium to produce magnesium oxide? Students conclude that there is no device that can count numbers of molecules or numbers of atoms. Teacher should emphasise that 1 mole is equal to Avogadro’s constant, 6.02 x 1023. It is a unit of measure and can be considered a ’counting word‘ (ie. it has a number meaning).  Students compare different counting words, like a couple (=2) or a dozen (=12), and then the mole (=6.02 x 1023). Like other counting words, the mole can be used to count anything. In chemistry, the mole is a standard number of particles, 6.02 x 1023 molecules, or atoms, or ions, etc. In fact, the mole is an SI Unit for an amount of any substance.  In groups, students are given a sample of a metal and asked to determine whether the sample represents a mole of the metal. Each group is then given a sample of another metal and asked to determine what fraction of a mole is present and how many atoms are present in the sample. There are balances available. Using information from the previous activity, students work on their own procedure. In this way students derive the mole equation . Emphasise should be placed on correct units and mathematical procedures. **CH11/12-6b** |  |
|  | **Student activity:** Research the internet to find the most useful media presentation that introduces or summarises the mole concept and justifythe choice made.  Examples: |  |
|  | [The Amazing Mole](http://www.vea.com.au/secondary-school/the-amazing-mole.html) | <http://www.vea.com.au/secondary-school/the-amazing-mole.html> |
|  | [The Mole Concept](https://www.youtube.com/watch?v=wORiAOnvw8g) | <https://www.youtube.com/watch?v=wORiAOnvw8g> |
| * explore the concept of the mole and relate this to Avogadro’s constant to describe, calculate and manipulate masses, chemical amounts and numbers of particles in: (ACSCH007, ACSCH039) * moles of elements and compounds  (n = chemical amount in moles, m = mass in grams, MM = molar mass in gmol-1) * percentage composition calculations and empirical formulae * limiting reagent reactions | Follow a procedure to estimate ‘Avogadro’s Number’ using a cube of any metal.  Students solve problems by performing calculations using the mole equations n=m/MM **CH11/12-6b**  **Investigation: The Molar Mass of an Element**  In groups, students design and conduct a primary investigation involving the combustion of magnesium and quantitatively determine the masses of magnesium and oxygen which combine to form the oxide. CH11/12-2 CH11/12-3 CH11/12-4  Students convert the masses into moles and compare the simple whole number mole ratio to the coefficients in the balanced chemical equation for the reaction. Remember that balanced equations need to satisfy the Law of Conservation of Mass.  Students use the results to determine the empirical formula of the oxide. **CH11/12-6** |  |
|  | Depth Study Background Information (2 hours)  **Investigation: The Molar Mass of a Compound**  In groups, design and conduct a first-hand investigation to identify the mass ratio of silver to nitrate in silver nitrate.**CH11/12-2 CH11/12-3 CH11/12-4**  Convert the masses into moles and compare the simple whole number mole ratio to the coefficients in the balanced chemical equation for the reaction.  Remember that balanced equations need to satisfy the Law of Conservation of Mass.  Use the results to determine the empirical formula of silver nitrate.  **CH11/12-6** |  |
| * conduct an investigation to determine that chemicals react in simple whole number ratios by moles | Solve problems to interpret the coefficients in chemical equations in terms of: (i) the number of particles; (ii) the number of moles of the species involved in the reaction. **CH11/12-6**  Complete text exercises on empirical and molecular formula. **CH11/12-6**  Deduce why the formulae of all metal-containing compounds are considered empirical.  *Teacher feedback on student practical reports and problems worksheet. Assessment for learning.* |  |
|  | [**Limiting Reagents – “s’mores analogy”**](https://molesandstoichiometry.wikispaces.com/file/view/chalk.doc)  In groups, investigate the following scenario to understand that it is the RATIO of reactants that is important in determining which is the limiting reactant.  Imagine you're on a camping trip and you and your friends are about to make s'mores. One of your friends was in charge of the marshmallows and brought an entire bag. You were in charge of the biscuits and brought a whole box. Another friend was in charge of the chocolate, but ate most of it on the car ride. Which ingredient will limit the number of s'mores that can be made? **CH11/12-3a CH11/12-6a**  *Teacher feedback on student practical reports and problems worksheet. Assessment for learning.*  . | <https://molesandstoichiometry.wikispaces.com/file/view/chalk.doc> |
|  | **Reflection**  **How are measurements made in chemistry?**  *Opportunity for self-assessment –assessment as learning*  Add tothe process diary about quantitative chemistry and the work of analytical chemists in chemical technology  Hours: 8  **Introduction**  Revise the terms solute and solvent  Define concentration  Depth study background information on how measurements are made in chemistry (2 hours) |  |

| **Topic: Concentration and Molarity** | | |
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| **Inquiry question:**  **How are chemicals in solutions measured?** | | |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
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| Students:   * conduct practical investigations to determine the concentrations of solutions and investigate the different ways in which concentrations are measured (ACSCH046, ACSCH063) * manipulate variables and solve problems to calculate concentration, mass or volume using: * c=n/v (molarity formula) (ACSCH063) * dilutions (number of moles before dilution = number of moles of sample after dilution) | **Investigation – concentrations of solutions 1:**  In small groups, follow a procedure to use gravimetric analysis to determine the concentration of potassium iodide in a solution. Evaluate and manage risks, ensure and evaluate accuracy, apply quantitative processes and evaluate the quality of the data collected. **CH11/12-3a,3 b, CH11/12-4**  Calculate the concentration in grams per litre and per cent composition.  **Investigation – concentrations of solutions 2:**  In small groups, follow a procedure to dilute food colouring in water from 100% composition to 0.001% composition. **CH11/12-3a,3 b**  Convert the percentage composition ratios to parts per million (ppm). **CH11/12-4b**  In jigsaw groups, research areas in the environment and industry where chemical technology is used to measure solution concentrations in grams per litre, per cent composition or parts per million. Give reasons why such measurements are useful.  Write a bibliography **CH11/12-3c** |  |
| * conduct an investigation to make a standard solution and perform a dilution | **Investigation – concentrations of solutions 3:**  Manipulate variables and solve problems to calculate concentration, mass or volume using:  – c=n/v (molarity formula) (ACSCH063)  – dilutions (number of moles before dilution = number of moles of sample after dilution) **CH11/12-4b, CH11/12-6**  In groups, conduct an investigation to make a standard solution and perform a dilution. **CH11/12-2, CH11/12-3,** **CH11/12-4, CH11/12-6**  Prepare a 250mL standard solution of 0.010mol/L potassium dichromate. Devise and perform an investigation to accurately dilute the standard solution to produce 20mL of 0.5g/L solution.  *Teacher feedback on student practical reports and problems worksheet. Assessment for learning.*  Add to the process diary about quantitative chemistry and the work of analytical chemists in chemical technology. |  |

| **Topic: Gas Laws** | | |
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| **Inquiry question:**  **How does the Ideal Gas Law relate to all other Gas Laws?** | | |
| **Content** | **Teaching, learning and assessment** | **Web Resources** |
|  | Hours: 5  **Stoichiometry and Gases – it’s what you don’t see that counts!**  When gases are produced in chemical reactions, it is often more important to know the volume of gas that is produced during a reaction than its mass.  At STP, 1 mole of any gas will occupy a volume of 22.414 L.  At non-STP conditions, the ideal gas law must be used. |  |
| Students:  ● conduct investigations and solve problems to determine the relationship between the Ideal Gas Law and:   * Gay-Lussac’s Law (temperature) * Boyle’s Law * Charles’s Law * Avogadro’s Law ACSCH060) | **Investigation – Gas Laws 1:**  Use a stoppered syringe to investigate how pressure relates to volume (Boyle’s Law) and temperature relates to volume (Charles’s Law).  Control variables, collect data and graph results. **CH11/12-4a, CH11/12-6a**  Make conclusions about the relationship between temperature and volume and between volume and pressure in gases. **CH11/12-6b**  Check the validity of the conclusions with secondary sources. **CH11/12-3c** |  |
|  | Use the following simulations to further understand Boyle’s and Charles’s Laws:  <http://www.grc.nasa.gov/WWW/K-12/airplane/boyle.html>  <http://www.grc.nasa.gov/WWW/K-12/airplane/glussac.html>  Describe the contribution of Gay-Lussac to the understanding of gaseous reactions and apply this to an understanding of the mole concept. | <http://www.grc.nasa.gov/WWW/K-12/airplane/boyle.html>  <http://www.grc.nasa.gov/WWW/K-12/airplane/glussac.html> |
|  | Recount Avogadro’s law and describe its importance in developing the mole concept.  **Investigation:**  Conduct the crushing can demonstration to show the relationship between pressure and temperature in gases. **CH11/12-2a, CH11/12-2c, CH11/12-3a,**  Research the Gas Laws explain the movement of the gas molecules in the crushing can demonstration. |  |
|  | Research to show that Charles’s Law, Boyle’s Law, Gay-Lussac’s Law and Avogadro’s Law are summed up in **CH11/12-6**the Ideal Gas Law: PV = nRT. **CH11/12-3c,** **CH11/12-6**  *Teacher feedback on student practical reports and research worksheet. Assessment for learning.* |  |

***Sample for implementation for Year 11 from 2018***

**Year 11 Chemistry**

**Module 2: Quantitative Chemistry**

**Depth Study: Chemical Technology**

**Task Description:**

Understanding quantitative relationships of reactants and products in chemical reactions is fundamental to chemical technology. The industrial production of fertilizer, the combustion of fuels, the treatment of water and the manufacture of cosmetics are some examples. In each case, it is necessary to understand reacting quantities and proportions of all reactants – solids, liquids and gases – in order to understand the technology used to monitor and control the products and processes.

1. You are asked to investigate a use of chemical technology in society.
2. In class, gather information about chemical reactions and stoichiometry and working scientifically. CH11-9, CH11/12-2, CH11/12-3, CH11/12-4.
3. Research the chemical reactions involved in the chemical technology chosen, including the reactants used and the products made. As quantitatively as you can, show the relationships of the reactants and the products. CH11-9, CH11/12-3, CH11/12-6
4. Gather information about the variety of chemical occupations employed in your chosen chemical technology. CH11/12-3
5. Outline the role of a practicing chemist employed in your chosen chemical industry and identify the branch of chemistry undertaken by the chemist.
6. You may extend your study to explain a chemical principle that the chemist uses (i.e. what type of chemical analysis that they do).
7. You may work on your own or with other like-minded people in your interest group.

**You will need to:**

1. Develop and evaluate a question or questions to investigate. CH11/12-1
2. Use a process diary to show the timing and sequence of your investigations as well as a bibliography. CH11/12-5
3. Present your research in an interesting and creative format using digital, visual, written or oral forms of communication. CH11/12-7

**Knowledge:**

CH11-9 Describe, apply and quantitatively analyse the mole concept and stoichiometric relationships

**Working Scientifically:**

CH11/12-1 Develop and evaluate questions and hypotheses for scientific investigation

CH11/12-2 Designs and evaluates investigations in order to obtain primary and secondary data and information

CH11/12-3 Conducts investigations to collect valid and reliable primary and secondary data and information

CH11/12-4 Selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media

CH11/12-5 Analyses and evaluates primary and secondary data and information.

CH11/12-6 Solves scientific problems using primary and secondary data, critical thinking skills and scientific processes

CH11/12-7 Communicates scientific understanding using suitable language and terminology for a specific audience or purpose

**Assessment for Learning**

This assessment for learning assessment criteria may be used by students and teachers to aid students to reflect upon their learning.

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| **Student Evaluation**  After you have prepared your presentation, answer the following questions.   1. How do you feel about the quality of the work that you are presenting? 2. If you had more time, what could you do to improve your process diary or presentation? 3. Which of the following skills do you think has shown the most improvement in your work during this task?   *thinking critically; conducting research; communicating clearly; taking responsibility; using technology; organizing information; making decisions*   1. Which of the above skills should you focus on for further improvement? 2. Use the marking criteriato assess your own performance during this task by circling the grade in each section. Justify (give reasons for) the final grade you gave yourself. | **Student/Teacher Assessment Criteria**  Knowledge and Understanding   1. Applies scientific ideas to solve the questions developed 2. Describes and connects some scientific ideas to solve the questions developed 3. Recalls relevant scientific information to help solve the questions developed 4. Recalls some basic scientific ideas to help solve the questions developed 5. With guidance, recalls some basic ideas to help solve the questions developed   Processing Information   1. Process diary shows thorough coverage of all aspects of the problem solving process 2. Process diary shows substantial coverage of all aspects of the problem solving process 3. Process diary shows coverage of most aspects of the problem solving process 4. Process diary shows limited coverage of the problem solving process 5. With guidance, Process diary shows coverage of the problem solving process   Problem Solving   1. Solution presented is creative and valid based on information researched 2. Solution is presented and validity has been attempted 3. Solution is creative but not supported by the research 4. Solution is presented within the time allowed 5. With guidance, a solution is presented or only a partial solution is presented within the time allowed |