2015 Year 11 Chemistry
Teaching and Learning Program

UNIT 1 – CHEMICAL FUNDAMENTALS; STRUCTURE, PROPERTIES AND REACTIONS
Learning Outcomes:
By the end of this unit, students: • understand how the atomic model and models of bonding explain the structure and properties of elements and compounds • understand the concept of enthalpy, and apply this to qualitatively and quantitatively describe and explain energy changes in chemical reactions • understand how models and theories have developed based on evidence from a range of sources, and the uses and limitations of chemical knowledge in a range of contexts • use science inquiry skills to design, conduct, evaluate and communicate investigations into the properties of elements, compounds and mixtures and the energy changes involved in chemical reactions • evaluate, with reference to empirical evidence, claims about chemical properties, structures and reactions • communicate, predict and explain chemical phenomena using qualitative and quantitative representations in appropriate modes and genres.

UNIT 2 – MOLECULER INTERACTIONS AND REACTIONS
Learning Outcomes:
By the end of this unit, students: • understand how models of the shape and structure of molecules and intermolecular forces can be used to explain the properties of substances, including the solubility of substances in water • understand how kinetic theory can be used to explain the behaviour of gaseous systems, and how collision theory can be used to explain and predict the effect of varying conditions on the rate of reaction • understand how models and theories have developed based on evidence from a range of sources, and the uses and limitations of chemical knowledge in a range of contexts • use science inquiry skills to design, conduct, evaluate and communicate investigations into the properties and behaviour of gases, water, aqueous solutions and acids and bases, and into the factors that affect the rate of chemical reactions • evaluate, with reference to empirical evidence, claims about chemical properties, structures and reactions • communicate, predict and explain chemical phenomena using qualitative and quantitative representations in appropriate modes and genres.

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Science Inquiry Skills (SIS):	Science as a Human Endeavour (SHE):	General capabilities and Cross-curricular priorities:
Questioning and predicting • identify, research and refine questions for investigation; propose hypotheses; and predict possible outcomes **Planning and conducting** • design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics • conduct investigations safely, competently and methodically for the collection of valid and reliable data, including: the use of devices to accurately measure temperature change and mass, flame tests, separation techniques, heat of reaction, chromatography, measuring pH, rate of reaction, identification of the products of reactions, and determination of solubilities of ionic compounds to recognise patterns in solubility **Processing and analysing data and information** • represent data in meaningful and useful ways, including using appropriate graphic representations and correct units and symbols; organise and process data to identify trends, patterns and relationships; identify sources of random and systematic error and estimate their effect on measurement results; identify anomalous data: and select, synthesise and use evidence to make and justify conclusions	**Property and structure of atoms** Findings from a range of scientific experiments contributed to the understanding of the atom, enabling scientists, including **Dalton**, **Thomson**, **Rutherford**, **Bohr** and **Chadwick** to develop models of atomic structure and make reliable predictions about the mass, charge and location of the sub-atomic particles. **Property and structure of materials** Matter at the **nanoscale** can be manipulated to create new materials, composites and devices; the different characteristics of **nanomaterials** can be used to provide commercially available products. As products are designed on the basis of properties which are different from the bulk material, their use can be associated with potential **risks** to health, safety and the environment and this has led to regulations being developed to address new and existing nanoform materials. **Chemical reactions; reactants, products and energy change** There are differences in the **energy output** and **carbon emissions** of fossil fuels (including **coal, oil, petroleum and natural gas)** and **biofuels (including biogas, biodiesel** and **bioethanol**). These differences, together with social, economic, cultural and political values, determine how widely these fuels are used.	**General capabilities:** Literacy Numeracy ICT capability Critical and creative thinking Personal and social capability Ethical behaviour Intercultural understanding **Cross-curricular priorities:** • Aboriginal and Torres Strait Islander histories and cultures • Sustainability *For a full description of the above:* http://wace1516.scsa.wa.edu.au/

Evaluating • interpret a range of scientific and media texts, and evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments **Communicating** • communicate to specific audiences and for specific purposes using appropriate language, nomenclature and formats, including scientific reports	**Intermolecular forces and gases** Chromatographic techniques, including thin layer chromatography (**TLC**), gas chromatography (**GC**), and high performance liquid chromatography (**HPLC**), are used to determine the components of a wide range of mixtures in various settings. The decision to use a particular chromatographic technique depends on a number of factors, including the properties of the substances being separated, the amount of substance available for analysis and the sensitivity of the equipment. Chromatographic techniques have a wide range of analytical and forensic applications, including monitoring air and water pollutants, drug testing of urine and blood samples, and testing for food additives and quality. **Aqueous solutions and acidity** The supply of potable drinking water is an extremely important issue for both Australia and countries in the Asian region. Water sourced from groundwater and seawater undergoes a number of purification and treatment processes (such as **desalination, chlorination, fluoridation**) before it is delivered into the supply system. Chemists regularly monitor drinking water quality to ensure that it meets the regulations for safe levels of solutes. **Heavy metal contamination** in ground water is monitored to ensure that concentrations are at acceptable levels. Several methods can be used to reduce heavy metal contamination; the method used is influenced by economic and social factors.	

	Rates of chemical reactions Catalysts are used in many industrial processes in order to increase the rates of reactions that would otherwise be uneconomically slow. Catalysts are also used to reduce the **emission of pollutants** produced by car engines. Motor vehicles have **catalytic converters** which are used to catalyse reactions that reduce the amount of carbon monoxide, unburnt petrol and nitrogen oxides that are emitted.	

Resources:	
Text: ▪ STAWA Exploring Chemistry Yr 11: Experiments, Investigations and Problems (2014) ▪ Exploring Chemistry Stage 2- Clarke et al. (2009). STAWA ▪ Exploring Chemistry Stage 3- Clarke et al. (2009). STAWA	Web: ▪ http://www.gcsescience.com ▪ http://www.chemguide.co.uk/analysis/masspec/howitworks.html

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No. of Lessons	ATAR Course Syllabus	Learning Objectives	Text Activities/Resources Prac: Practical lab activity AS: Activity sheet PPT: PowerPoint AV: Movie/animation/Podcast	Formative and Summative Assessment
	• elements are represented by symbols			
	• atoms can be modelled as a nucleus, surrounded by electrons in distinct energy levels, held together by electrostatic forces of attraction between the nucleus and electrons; the location of electrons within atoms can be represented using electron configurations		**STAWA Stage 2 – Set 4 & 6**	
	• the ability of atoms to form chemical bonds can be explained by the arrangement of electrons in the atom and in particular by the stability of the valence electron shell			
	• the structure of the periodic table is based on the atomic number and the properties of the elements		**STAWA Stage 2 – Set 5** Compare the groupings obtained in the data sorting exercise with Mendeleev's Periodic Table	Periodic table scavenger hunt
	• SHE - Findings from a range of scientific experiments contributed to the understanding of the atom, enabling scientists, including Dalton, Thomson, Rutherford, Bohr and Chadwick to develop models of atomic structure and make reliable predictions about the mass, charge and location of the sub-atomic particles.		Research and report on the evidence provided by the work of another individual who has made a contribution to the development of the Periodic Table or atomic theory Conduct experiments demonstrating trends within the Periodic Table based on data about the physical and chemical properties of a number ofelements, and their position in the Periodic Table, in groups or individually predict the properties of other elements; compare predictions with actual properties youtube atoms & astronomy	**Extended Response & Validation Test:** The model of the atom/PT has changed over time.

	• the elements of the periodic table show trends across periods and down main groups, including in atomic radii, valencies, 1st ionisation energy and electronegativity as exemplified by groups 1, 2, 13–18 and period 3		**STAWA Stage 3 – Sets 9 & 11** Fakebook (classtools.net) for elements	
	• flame tests and atomic absorption spectroscopy (AAS) are analytical techniques that can be used to identify elements; these methods rely on electron transfer between atomic energy levels and are shown by line spectra		http://www.hsc.csu.edu.au/chemistry/core/monitoring/chem943/943net.html#net9 **STAWA Stage 2 – Expt 7 Flame tests** Describe the use of atomic absorption spectroscopy (AAS), in detecting concentrations of metal ions in solutions and assess its impact on scientific understanding of the effects of trace elements - Perform a first-hand investigation to identify ions. Monitoring of air and foodstuffs for lead. Perform a first-hand investigation into the sulfate content of lawn fertiliser. Gather, process and present information to interpret secondary data from AAS measurements and evaluate the effectiveness of this in pollution control - A case study in the monitoring of arsenic.	**Invest:** ASS use in a real life context
	• isotopes are atoms of an element with the same number of protons but different numbers of neutrons and are represented in the form ^{A}X (IUPAC) or X-A			

	• isotopes of an element have the same electron configuration and possess similar chemical properties but have different physical properties			
	• the relative atomic mass (atomic weight), A_r is the ratio of the average mass of the atom to 1/12 the mass of an atom of ^{12}C; relative atomic masses of the elements are calculated from their isotopic composition			
	• mass spectrometry involves the ionisation of substances and the separation and detection of the resulting ions; the spectra which are generated can be analysed to determine the isotopic composition of elements and interpreted to determine relative atomic mass		http://science.howstuffworks.com/mass-spectrometry.htm http://biotechbinge.com/biotechnology/2012/11/top-five-coolest-uses-of-mass-spectrometry/ Matches on pegboard and ball activity - Finding environmental toxins - Testing for steroid use in athletes - Fighting terrorism - Exploring the universe - Drug development – M Buntine, The University of Adelaide *Chemistry Blackman p.778* Crime Scene investigations	
	• materials are pure substances with distinct measurable properties, including melting and boiling points, reactivity, hardness and density; or mixtures with properties dependent on the identity and relative amounts of the substances that make up the mixture		Separations techniques eq distillation, filtration	
	• pure substances may be elements or compounds which consist of atoms of two or more elements chemically combined; the formulae of compounds indicate the	•		

	relative numbers of atoms of each element in the compound			
	• nanomaterials are substances that contain particles in the size range 1–100 nm and have specific properties relating to the size of these particles which may differ from those of the bulk material		http://science.howstuffworks.com/nanotechnology3.htm http://www.nano.gov/nanotech-101 http://www.technewsdaily.com/5724-nanotech.html Colloidal gold experiment - Sunsceen (MB to check with Curtin) - Self cleaning glass - Clothing - Anti-microbial bandages - Carbon nanotubes Water treatment	**Extended Response & Validation Test:** Applications of Nanotechnology
	• differences in the physical properties of substances in a mixture, including particle size, solubility, density, and boiling point, can be used to separate them	•		Distillation
	• the type of bonding within ionic, metallic and covalent substances explains their physical properties, including melting and boiling points, conductivity of both electricity and heat and hardness	•	**STAWA Stage 2 – Sets 7**	**STAWA Stage 3** – Invest 4 Exploring Properties
	• chemical bonds are caused by electrostatic attractions that arise because of the sharing or transfer of electrons between participating atoms; the valency is a measure of the bonding capacity of an atom	•		
	• ions are atoms or groups of atoms that are electrically charged due to a loss or gain of electrons; ions are represented by formulae which include the number of constituent atoms and the charge of the ion	•		

	(for example, O^{2-}, SO_4^{2-}) • ionic bonding can be modelled as a regular arrangement of positively and negatively charged ions in a crystalline lattice with electrostatic forces of attraction between oppositely charged ions • the ionic bonding model can be used to explain the properties of ionic compounds, including high melting point, brittleness and non-conductivity in the solid state; the ability of ionic compounds to conduct electricity when molten or in aqueous solution can be explained by the breaking of the bonds in the lattice to give mobile ions • the formulae of ionic compounds can be determined from the charges on the relevant ions (refer to Appendix 2 of course documents)			
	• metallic bonding can be modelled as a regular arrangement of atoms with electrostatic forces of attraction between the nuclei of these atoms and their delocalised electrons that are able to move within the three dimensional lattice • the metallic bonding model can be used to explain the properties of metals, including malleability, thermal conductivity, generally high melting point and electrical conductivity;	•		
	• covalent bonding can be modelled as the sharing of pairs of electrons resulting in electrostatic forces of attraction between the shared electrons and the nuclei of adjacent atoms • the properties of covalent network substances, including high melting point, hardness and electrical conductivity, are explained by modelling covalent networks as three-dimensional structures that comprise covalently bonded	•		**Extended Response & Validation Test:** Allotropes of Carbon Task **Test 1: Atomic Structure and Bonding**

	atoms • elemental carbon exists as a range of allotropes, including graphite, diamond and fullerenes, with significantly different structures and physical properties • the properties of covalent molecular substances, including low melting point, can be explained by their structure and the weak intermolecular forces between molecules; their non-conductivity in the solid and liquid/molten states can be explained by the absence of mobile charged particles in their molecular structure • molecular formulae represent the number and type of atoms present in the molecules (refer to Appendix 2 of course documents)		Make lampblack and industrial diamonds **STAWA Stage 2 – Expt 3 Cooling Curves** Thermometers soaked with various solvents	
	• percentage composition of a compound can be calculated from the relative atomic masses of the elements in the compound and the formula of the compound	•	**STAWA Stage 2 – Set 12**	
	• the valence shell electron pair repulsion (VSEPR) theory and Lewis structure diagrams can be used to explain, predict and draw the shapes of molecules			
	• the polarity of molecules can be explained and predicted using knowledge of molecular shape, understanding of symmetry, and comparison of the electronegativity of atoms involved in the bond formation			
	• the shape and polarity of molecules can be used to explain and predict the nature and strength of intermolecular forces, including dispersion forces, dipole-dipole forces and hydrogen bonding			
	• data from chromatography techniques, including thin layer chromatography (TLC), gas chromatography (GC),		**STAWA Stage 3 – Invest 5 (ADAPT)**	

	and high-performance liquid chromatography (HPLC), can be used to determine the composition and purity of substances; the separation of the components is caused by the variation in strength of the interactions between atoms, molecules or ions in the mobile and stationary phases			
	• SHE - Chromatographic techniques, including thin layer chromatography (TLC), gas chromatography (GC), and high performance liquid chromatography (HPLC), are used to determine the components of a wide range of mixtures in various settings. The decision to use a particular chromatographic technique depends on a number of factors, including the properties of the substances being separated, the amount of substance available for analysis and the sensitivity of the equipment. Chromatographic techniques have a wide range of analytical and forensic applications, including monitoring air and water pollutants, drug testing of urine and blood samples, and testing for food additives and quality.		Investigate aspirin using thin layer chromatography.	
	• chemical reactions can be represented by chemical equations; balanced chemical equations indicate the relative numbers of particles (atoms, molecules or ions) that are involved in the reaction		**STAWA Stage 2 – Expt 12** **STAWA Stage 2 – Invest 11** **STAWA Stage 2 – Set 13** **STAWA Stage 2 – Expt 21**	**Article of interest:** The future of energy use and its implication to environmental science *Chemistry, Silberberg p.249*
	• chemical reactions and phase changes involve enthalpy changes, commonly observable as changes in the temperature of the surroundings and/or the emission of			**Test 2: Chemical Reactions**

	light • endothermic and exothermic reactions can be explained in terms of the Law of Conservation of Energy and the breaking of existing bonds and forming of new bonds; heat energy released or absorbed by the system to or from the surroundings, can be represented in thermochemical equations		**STAWA Stage 2 – Expt 14** **STAWA Stage 2 – Invest 8**	
	• *fossil fuels (including coal, oil, petroleum and natural gas) and biofuels (including biogas, biodiesel and bioethanol) can be compared in terms of their energy output, suitability for purpose, and the nature of products of combustion*		**www.vcaa.vic.edu.au/Documents/vce/chemistry/biofuelschemistry.doc** **STAWA Stage 2 – Expt 15** SHE: Compare heats of combustion of various fuels Calibrate a calorimeter and use a data logger to determine the enthalpy for a chemical reaction, e.g. hydrochloric acid and sodium hydroxide or heat of hydration of copper(II) sulfate Complete exercises involving the manipulation of heats of reaction	**Investig & Validation Test:** EC11-fossil fuel 2nd hand data (Bernie)
	• the mole is a precisely defined quantity of matter equal to Avogadro's number of particles		**STAWA Stage 2 – Expt 13** **STAWA Stage 2 – Set 9-11, 14, 17**	
	• the mole concept relates mass, moles and molar mass and, with the Law of Conservation of Mass; can be used to calculate the masses of reactants and products in a chemical reaction		**STAWA Stage 2 – Invest 5** **STAWA Stage 2 – Set 16**	**Investig** – EF of MgO (Modify STAWA Expt 10)
	• the behaviour of an ideal gas, including the qualitative relationships between pressure, temperature and volume, can be explained using the Kinetic Theory			
	• the mole concept can be used to calculate the mass of		**STAWA Stage 2 – Sets 18, 19 & 20**	

	• the mole concept can be used to calculate the mass of substances and volume of gases (at standard temperature and pressure) involved in a chemical reaction		**STAWA Stage 2 – Sets 18, 19 & 20**	
	• observable properties, including vapour pressure, melting point, boiling point and solubility, can be explained by considering the nature and strength of intermolecular forces within a covalent molecular substance		**STAWA Stage 3 – Expt 8** **STAWA Stage 3 – Set 10**	
	• the unique physical properties of water, including melting point, boiling point, density in solid and liquid phases and surface tension, can be explained by its molecular shape and hydrogen bonding between molecules			
	• solutions can be classified as saturated, unsaturated or supersaturated; the concentration of a solution is defined as the quantity of solute dissolved in a quantity of solution; this can be represented in a variety of ways, including by the number of moles of the solute per litre of solution (mol L-1) and the mass of the solute per litre of solution (g L-1) or parts per million (ppm)		**STAWA Stage 2 – Sets 22 &23**	**SHE**- Solubility curves for different substances
	• the presence of specific ions in solutions can be identified by observing the colour of the solution, flame tests and observing various chemical reactions, including precipitation and acid-base reactions		**STAWA Stage 2 – Set 13**	
	• the solubility of substances in water, including ionic and polar and non-polar molecular substances, can be explained by the intermolecular forces, including ion-dipole interactions between species in the substances and water molecules, and is affected by changes in			

	• the mole concept can be used to calculate the mass of solute, and solution concentrations and volumes involved in a chemical reaction			
	• SHE - The supply of potable drinking water is an extremely important issue for both Australia and countries in the Asian region. Water sourced from groundwater and seawater undergoes a number of purification and treatment processes (such as desalination, chlorination, fluoridation) before it is delivered into the supply system. Chemists regularly monitor drinking water quality to ensure that it meets the regulations for safe levels of solutes. Heavy metal contamination in ground water is monitored to ensure that concentrations are at acceptable levels. Several methods can be used to reduce heavy metal contamination; the method used is influenced by economic and social factors.			**Investig & Validation Test:** Water Quality research, practical & validation test
	• the Arrhenius model can be used to explain the behaviour of strong and weak acids and bases in aqueous solutions			
	• indicator colour and the pH scale are used to classify aqueous solutions as acidic, basic or neutral		**STAWA Stage 3 – Expt 9** **STAWA Stage 3 – Invests 6 & 7** **STAWA Stage 3 – Sets 15 & 16**	
	• pH is used as a measure of the acidity of solutions and is dependent on the concentration of hydrogen ions in the solution		**STAWA Stage 2 – Expt 19 & 20** **STAWA Stage 2 – Invest 12**	
	• patterns of the reactions of acids and bases, including reactions of acids with bases, metals and carbonates and the reactions of bases with acids and ammonium salts, allow products and observations to be predicted from reactants; ionic equations represent the reacting species		**STAWA Stage 2 – Expts 22, 23 & 24** **STAWA Stage 2 – Invest3 & 14**	**Test 3: Aqueous Solutions and Acidity**

	and products in these reactions			
	• varying the conditions under which chemical reactions occur can affect the rate of the reaction		**Lucarelli (2AB) – Set 15**	
	• the rate of chemical reactions can be quantified by measuring the rate of formation of products or the depletion of reactants		**STAWA Stage 2 – Expts 16, 17 & 18** Expt - Acid carbonate reactivity - measuring loss over time **STAWA Stage 2 – Invest 9**	
	• collision theory can be used to explain and predict the effects of concentration, temperature, pressure, the presence of catalysts and surface area on the rate of chemical reactions			
	• the activation energy is the minimum energy required for a chemical reaction to occur and is related to the strength and number of the existing chemical bonds; the magnitude of the activation energy influences the rate of a chemical reaction			
	• energy profile diagrams, which can include the transition state and catalysed and uncatalysed pathways, can be used to represent the enthalpy changes and activation energy associated with a chemical reaction			
	• catalysts, including enzymes and metal nanoparticles, affect the rate of certain reactions by providing an alternative reaction pathway with a reduced activation energy, hence increasing the proportion of collisions that lead to a chemical change			
	• SHE - Catalysts are used in many industrial processes in order to increase the rates of reactions that would otherwise be uneconomically slow. Catalysts are also used to reduce the emission of pollutants produced by			

	• SHE - Catalysts are used in many industrial processes in order to increase the rates of reactions that would otherwise be uneconomically slow. Catalysts are also used to reduce the emission of pollutants produced by car engines. Motor vehicles have catalytic converters which are used to catalyse reactions that reduce the amount of carbon monoxide, unburnt petrol and nitrogen oxides that are emitted.			
	• hydrocarbons, including alkanes, alkenes and benzene, have different chemical properties that are determined by the nature of the bonding within the molecules • molecular structural formulae (condensed or showing bonds) can be used to show the arrangement of atoms and bonding in covalent molecular substances • IUPAC nomenclature is used to name straight and simple branched alkanes and alkenes from C_1- C_8 • alkanes, alkenes and benzene undergo characteristic reactions such as combustion, addition reactions for	•	**STAWA Stage 2 – Sets 9 & 11** **STAWA Stage 2 – Expt 29** **STAWA Stage 2 – Sets 27-29** Expt: Iodine substitution & addition **STAWA Stage 2 – Invest 16 & 17**	**Test 4: Hydrocarbons**