STAWA DEPTH and BREADTH of CONTENT: Teacher Support Documents

Senior Secondary Science WACE 2015 – 2016: Chemistry - Unit 1

The STAWA Depth & Breadth of Content documents have been developed through the collaboration of teachers working in Department of Education, Catholic Education and Independent Schools.

Purpose

The STAWA Depth & Breadth of Content documents are intended to promote a shared understanding of the course content that improves moderation across schools, regions and systems/sectors.

Caution

The Depth and Breadth points of elaboration are interpretations. The ATAR syllabus content statements are the only parts of these documents that are mandated. Examiners are required to address the mandated statements only.

The STAWA Depth & Breadth of Content documents are a great example of teachers helping teachers for the benefit of all students.

www.stawa.net

Leadership in Science Education

CHEMISTRY

ATAR Year 11

Unit 1 – Chemical fundamentals: structure, properties and reactions

Unit description

Chemists design and produce a vast range of materials for many purposes, including for fuels, cosmetics, building materials and pharmaceuticals. As the science of chemistry has developed over time, there has been an increasing realisation that the properties of a material depend on, and can be explained by, the material's structure. A range of models at the atomic and molecular scale enable explanation and prediction of the structure of materials and how this structure influences properties and reactions. In this unit, students relate matter and energy in chemical reactions as they consider the breaking and reforming of bonds as new substances are produced. Students can use materials that they encounter in their lives as a context for investigating the relationships between structure and properties.

Through the investigation of appropriate contexts, students explore how evidence from multiple disciplines and individuals have contributed to developing understanding of atomic structure and chemical bonding. They explore how scientific knowledge is used to offer reliable explanations and predictions, and the ways in which it interacts with social, economic and ethical factors.

Students use science inquiry skills to develop their understanding of patterns in the properties and composition of materials. They investigate the structure of materials by describing physical and chemical properties at the macroscopic scale, and use models of structure and primary bonding at the atomic and sub-atomic scale to explain these properties. They are introduced to the mole concept as a means of quantifying matter in chemical 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 content

This unit includes the knowledge, understandings and skills described below.

Science Inquiry Skills

Unit Content	Elaborations	Possible Activities	Assessment Opportunities
1. identify, research and refine questions for investigation; propose hypotheses; and predict possible outcomes			
2. 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			

3. 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 and heat of reaction	• Identify, by observation, exothermic and endothermic reactions. • Use simple calorimetric techniques to measure the molar heat of reaction. • Choose and apply appropriate separation techniques, including filtration, recrystallization, distillation and to separate the components of a given mixture. • Use flame tests to identify or confirm the presence of metal ions.		
4. 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; and select, synthesise and use evidence to make and justify conclusions	• Choose appropriate graphical representations including when to use lines of best fit. • Define random error as • Define systematic error as • Identify random and systematic errors in experiments and investigations. • Estimate the effect of random and systematic errors on quantitative results. • Suggest ways in which random errors can be reduced		

5. 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			
6. communicate to specific audiences and for specific purposes using appropriate language, nomenclature and formats, including scientific reports			

Science as a Human Endeavour

Properties and structure of atoms

Science Understanding

Unit Content	Elaboration	Activities	Assessment opportunities
1. elements are represented by symbols	• Write the symbols and names of the following elements: H, He, Li, Be, B, C, N, O, F, Ne, Na, Mg, Al, Si, P, S, Cl, Ar, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Br, Sr, Ag, Sn, I, Ba, Pt, Au, Hg, Cd and Pb. (This elaboration may be unnecessary as the names are now given in the data sheet on the Periodic Table)	**CWA1 – Chapter 1** **Lucarelli (2AB) – Set 6**	
2. 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	• List the relative charges and masses of protons, neutrons and electrons • State that the atom has a dense, positively charged nucleus consisting of protons and neutrons, around which move negatively charged electrons. • State that an element is identified by its atomic number (Z) which determines the number of electrons in a neutral atom of the element. • Define the mass number (A) of an atom as the total number of protons and neutrons in the nucleus of an atom. • From the relationship between atomic number and mass number, determine the number of protons, neutrons and electrons in an atom or monatomic ion. • Write symbolic representations of elements and monatomic ions showing A, Z and charge.	**STAWA Stage 2 – Set 4 & 6** Calculation of p, n and e^- Calculation of the above in valence form	

	• State that the electrons in an atom are located in energy levels or shells. • Write the electron configuration of the first twenty elements and their monatomic ions (shell only).		
3. 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	• Identify the valence electrons of an atom. • Determine, using the Periodic Table, the number of valence electrons in the main group elements. • State that the number of valence electrons in the atoms of an element is the most important factor in determining the chemical properties of the element. • Identify that an outer shell of eight electrons is a stable configuration. • Explain how positive ions and negative ions are formed by the donation and acceptance of valence electrons. • Relate the charges of the monatomic ions formed by the main group elements to their position on the Periodic Table. • Write the symbols and names of the monatomic ions as shown in Appendix 2. • State that valence electrons are involved in electron transfer or sharing to achieve a stable electron arrangement. • State and apply that valency is a measure of bonding capacity.		
4. the structure of the periodic table is based on the atomic number and the properties of the elements	• State that the Periodic Table is arranged in order of increasing atomic number. • Relate the arrangement of elements in the Periodic Table to their electron configuration. • State that the main groups of the Periodic Table	**STAWA Stage 2 – Set 5** Compare the groupings obtained in the data sorting exercise with Mendeleev's	Periodic table scavenger hunt

	represent elements with similar chemical properties and the same number of valence electrons. • State that the periods of the Periodic Table represent the number of occupied electron shells. • Locate the position of an element in the Periodic Table from its electron configuration. • Given the position on the Periodic Table of a main group element, predict chemical properties. • State the common names for Groups 1, 2, 17 and 18.	Periodic Table Use data about hypothetical elements to arrange them into a 'periodic table'	
5. 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	• Define ionisation energy as the energy required to remove one mole of electrons from one mole of atoms or ions in the gas phase. • State and explain the variation in the first ionisation energy down a group and across a period in the Periodic Table. • State and explain the trend in the successive ionisation energies for an element. • State and explain the variation in atomic radius down a group and across a period in the Periodic Table. • Define electronegativity of an atom in terms of its ability to attract electrons within a covalent bond. • State and explain the variation in electronegativity down a group and across a period in the Periodic Table. • Describe and explain the variation in physical properties across a period. • Describe and explain the physical and chemical properties down a group.	**CWA2 – Chapter 1** **Lucarelli (3AB) – Sets 3 & 6** **STAWA Stage 3 – Sets 9 & 11** Fakebook (classtools.net) for elements	

Science as a Human Endeavour 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.	• Describe and explain the contributions of each of the following scientists to the development of the atomic model: o Dalton o Thomson, o Rutherford, o Bohr o Chadwick • Draw labelled diagrams and explain the structure of each of the atomic models associated with the scientists listed above. • Draw and label a timeline showing the development of the atomic model. • Explain how changes in technology have contributed to the atomic model and our understanding of the atom.	Research and report on the evidence provided by the work of another individualwho has made a contribution to the development of the Periodic Table or atomictheory Conduct a web search to identify various forms of the current Periodic Table 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 1:** The model of the atom/PT has changed over time.
6. mass spectrometry involves the ionisation of substances and the separation and detection of the resulting ions; the spectra which are generated can be analysed	• Explain the process of ionisation with respect to mass spectroscopy. • Identify and explain the main processes that occur in a mass spectrometer including ionisation (atomisation), acceleration, deflection and detection. • Relate the degree of deflection to charge and mass of a charged species.	http://science.howstuffworks.com/mass-spectrometry.htm http://biotechbinge.com/biotechnology/2012/11/top-five-coolest-uses-of-mass-spectrometry/	

to determine the isotopic composition of elements and interpreted to determine relative atomic mass	• Interpret a spectra produced by a mass spectrometer and calculate the relative atomic mass of the sample.	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	
7. 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	• Define isotopes as atoms with the same number of protons and different numbers of neutrons. • Explain the existence of isotopes in terms of the neutron content of the nucleus. • Represent different isotopes in the form ^{A}X (IUPAC) or X-A.	Distinguish between atoms that are different elements and those that are different isotopes of the same element.	
8. isotopes of an element have the same electron configuration and possess similar chemical properties but have different physical properties	• Give examples of isotopes that have similar chemical properties but different physical properties, such as hydrogen, carbon and cobalt. • Describe differences in physical properties of isotopes of the same element, such as hydrogen, carbon and cobalt. • Predict the chemical behaviour of an isotope given the properties of another isotope of the same element.	Predict the chemical behaviour of one isotope given the properties of another of the same element. - Medicine - Cancer treatment - Carbon dating	
9. the relative atomic mass (atomic weight), Ar is the ratio of the average mass	• Define relative atomic mass (atomic weight) as the ratio of the average mass of the atom to 1/12 the mass of an atom of 12C.	Perform calculations of relative atomic masses from abundances and relative	

of the atom to 1/12 the mass of an atom of 12C; relative atomic masses of the elements are calculated from their isotopic composition	• Explain the existence of fractional atomic masses of some elements in terms of the existence of naturally occurring isotopes. • Calculate the relative atomic mass given the isotopic mass and relative abundances of the isotopes of an element. • Calculate relative abundance of an isotope given relative atomic mass and abundance of other isotopes of an element.	isotopic masses	
10. 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	• Explain, with the aid of diagrams, how movement of electrons between shells or energy levels, produces the emission spectra responsible for the observations in flame tests. • Use flame tests to identify the following metal ions: potassium, sodium, strontium, calcium, barium, copper (and some others). • Describe how atomic absorption spectroscopy (AAS) is used to identify elements. • Label a simple of diagram of an atomic absorption spectrometer. • Distinguish between the emission spectra associated with flame tests and the absorption spectra associated with AAS. • Describe each of the following aspects of the operation of an AAS ○ Atomiser ○ Light source (monochromatic) ○ Detector ○ Output/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.	**Prac and Validation Test 1:** ASS use in a real life context

	• Examples • Discuss electron configurations / orbital's and electrons in an excited state to help explain how AAS works • Atomic absorption spectroscopy (AAS) is a procedure used for the quantitative determination of chemical elements using the absorption of light by free atoms in the gas phase. Describe the use of atomic absorption spectroscopy (AAS) in detecting concentrations of metal ions in solutions • Describe the AAS processes have allowed for trace elements to be detected and analysed. • View emission spectra of various elements • Interpret a series of ionisation energies as evidence for electron shells and subshells	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.	

Science as a Human Endeavour

Properties 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.

Science Understanding

Unit Content	Elaboration	Activities	Assessment opportunities
11. 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	• State and compare the characteristics of homogeneous and heterogeneous substances. • Distinguish between pure substances (elements and compounds), homogeneous mixtures and heterogeneous mixtures. • Define the properties of melting point, boiling point, hardness, density and hardness. • Explain the relationship between the identity and relative amounts of substances in a mixture and its properties.	Separations techniques eq distillation, filtration **STAWA Stage 2 – Expt 2 & 3**	
12. pure substances may be elements or compounds which consist of atoms of two or more elements chemically combined; the formulae of compounds	• Define pure substances as elements or compounds. • Define compounds as substances, which consist of two or more elements chemically combined. • Write the formulae of compounds formed from the ions given in appendix y and the name the compounds. • State that the formula of an ionic or covalent network	Exercises requiring students to Interpret formulae, write formulae	

indicate the relative numbers of atoms of each element in the compound	compound represents the relative number of each element present. • Write the formula and name common covalent molecular substances. • State that the formula of a covalent molecular substance represents the number and type of elements present in the substance.		
13. 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	• Define nanomaterials as substances that contain particles in the size range 1 – 100 nm. • State and describe how the properties of nanomaterials may differ from the properties of the bulk material and give examples, such as standard zinc oxide sunscreen and nano zinc oxide sunscreen.	**http://science.howstuffworks.com/nanotechnology3.htm** **http://www.nano.gov/nanotech-101** **http://www.technewsdaily.com/5724-nanotech.html** investigate and report on one aspect of the uses of nanomolecules or an application of nanotechnology, e.g. in the manufacture of sunscreens Colloidal gold experiment	Applications of Nanotechnology
Science as a Human Endeavour Matter at the nanoscale can be manipulated to create new materials, composites and devices; the different characteristics of	• Describe the potential health risks associated with the use of nano zinc oxide. • Identify uses of carbon nanotubes and suggest advantages and disadvantages to their use. • Describe and explain examples of environmental concerns associated with the use of nanomaterials. • Provide a balanced discussion of the advantages and	Research one of the following applications of nanotechnology. Present your findings in a written, oral or multimedia format. a. Carbon nanotubes	

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.	disadvantages of nanomaterials	b. Nanoparticles in sunscreens c. Nanoparticles in electronics d. Nanoparticles in medicine e. Nanoparticles in water treatment	
14. differences in the physical properties of substances in a mixture, including particle size, solubility, density, and boiling point, can be used to separate them	• Select, describe and justify suitable methods for separating mixtures. • For each procedure, identify and explain the physical property that enables that method of separation, for example, filtration and particle size/solubility, boiling point and fractional distillation etc. • Explain the roles of decantation, filtration, recrystallization, distillation and fractional distillation in the purification of substances.	**STAWA Stage 2 – Expt 1 & Invest. 1** Chromatography experiments	Distillation
15. 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	• State and apply that bonding in compounds containing elements from groups 1 or 2 of the Periodic Table combined with groups 16 and 17 is ionic. • State and apply that when elements on the right hand side of the Periodic Table combine with other elements on the right hand side of the Periodic Table, covalent compounds are formed.	**STAWA Stage 2 – Sets 7** **STAWA Stage 2 – Expt 8 & 9**	**STAWA Stage 3** – Invest 4 Exploring Properties

hardness	• Classify substances as ionic, covalent molecular, covalent network or metallic based on their physical properties. • Describe the general properties of metals, ionic compounds, and covalent molecular and covalent network substances.		
16. 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	• Explain the relationship between valency and bonding capacity. • Explain how the transfer of electrons creates ions to enable the formation of ionic bonding. • Explain how positive ions (cations) and negative ions (anions) are formed by the donation and acceptance of valence electrons. • Define covalent bonding as the sharing of electrons between adjacent nuclei. • Describe the electrostatic nature of metallic bonding in terms of the attraction of metal ions for delocalised electrons.		
17. 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, O2–, SO42–)	• Define ions as atoms or groups of atoms that are electrically charged due to a loss or gain of electrons. • Relate the charges of the monatomic ions formed by the main group elements to their position on the Periodic Table. • Use the chemical stability of an outer shell octet to explain why particular ions form from the parent atom, and to predict the formula of the simple ionic compounds. • Draw electron dot diagrams/Lewis structures of monatomic and polyatomic ions. • Write the formulas for monatomic and polyatomic ions	**CWA1 – Chapter 3** **Lucarelli (2AB) – Sets 7 & 9** Identify why living things require many of the elements for life in the form of ions Given a chemical formula, provide the name of ionic compounds that involve simple and polyatomic ions Given the name of an ionic compound, write the formula	

	listed in appendix 2	Draw electron dot diagrams of monatomic ions and ionic compounds	
18. 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	• Describe ionic bonding as electrostatic attraction between oppositely charged ions in solids. • Describe an ionic solid as a lattice of positive and negative ions and explain the evidence of such an ionic lattice in terms of the electrostatic attraction between oppositely charged ions.	**CWA1 – Chapter 2** **Lucarelli (2AB) – Set 8** Draw a model of a simple ionic crystal showing the arrangement of ions.	**Extended Response & Validation Test 2:** Allotropes of Carbon Task
19. 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	• Use the nature of the ionic lattice structure and the attraction between the oppositely charged ions to explain the physical properties ○ High melting and boiling points ○ Electrical conductivity in the molten state and aqueous solutions ○ Brittleness ○ Hardness	Classify compounds as ionic on the basis of given properties Predict properties of compounds, given information that they are ionic Draw a diagram to represent and explain the brittle behaviour of ionic compounds	
20. the formulae of ionic compounds can be determined from the charges on the relevant ions (refer to Appendix 2)	• Write the formulae for and name ionic compounds from the ions listed in Appendix 2.		
21. metallic bonding can be modelled as a regular	• Describe a metal lattice as an array of positive metal ions	Draw or construct a model of a metallic lattice or view a	

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	interspersed with delocalised electrons.	computer simulation of a metallic lattice	
22. the metallic bonding model can be used to explain the properties of metals, including malleability, thermal conductivity, generally high melting point and electrical conductivity;	• Describe the metal lattice as an array of positive metal ions interspersed with delocalised valence electrons. • Use the nature of the metallic lattice and the presence of delocalised electrons to explain the properties ○ Melting and boiling point ○ High thermal and electrical conductivity ○ Malleability and ductility. ○ Hardness	Predict properties of substances that are stated to be metallic Predict and explain trends in boiling temperatures of metals in the periodic table Given a set of properties associated with a metal, predict whether it could be used for particular purposes	
23. 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	• Describe the electrostatic nature of the covalent bond in terms of attraction of both nuclei for the shared electron pair(s). • State and apply that covalent bonding is restricted to atoms having similar and high electronegativities and that such elements are generally non-metals. • Explain the formation of single and multiple covalent bonds in simple molecules of elements, relating this to the electron configuration of the atoms involved. • Explain that single and multiple covalent bonds may also exist in compounds and cite examples of such compounds.		

	• State and apply that the number of covalent bonds formed by a particular atom can be related to its position on the Periodic Table. • Draw electron dot/Lewis diagrams for simple molecular substances (octet rule only).		

24. 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 atoms	• Describe the structure of covalent network substances as three-dimensional lattices of atoms bonded by covalent bonds.
	• Use the nature of the three-dimensional covalently bonded structure of covalent network substances to explain the physical properties
	  ○ High melting and boiling point
	  ○ Hardness
	  ○ Brittleness
	  ○ Non electrical conductivity
	• List carbon, silicon, silicon dioxide and silicon carbide as examples of covalent network substances.
	• Identify unknown covalent network substances from their characteristic properties.
		Classify substances as covalent network on the basis of given information about properties	

25. elemental carbon exists as a range of allotropes, including graphite, diamond and fullerenes, with significantly different structures and physical properties	• Define allotropes as the same element with different bonding arrangements resulting in different chemical and physical properties.
	• Describe the structural differences between graphite, diamond and fullerenes and relate these structural differences to the properties observed for each allotrope, such as
	  ○ Hardness
	  ○ Electrical conductivity
	  ○ Melting and boiling point
		Make lampblack and industrial diamonds	**Test 1: Atomic Structure and Bonding**

	• Use diagrams to illustrate the structural differences between the allotropes of carbon. • Relate the different uses of the allotropes of carbon to their structural differences.		

26. 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	• Distinguish between covalent molecular substances and covalent network substances.
	• Describe the structure of a covalent molecular solid as a regular arrangement of molecules held together with weak intermolecular forces.
	• Use the presence of weak intermolecular forces and the absence of mobile charges to explain properties such as
	  ○ Relatively low melting and boiling points
	  ○ Non-conductivity as solids and liquids (molten)
	  ○ Softness
		STAWA Stage 2 – Expt 3 Cooling Curves
		Thermometers soaked with various solvents
		Classify substances as covalent molecular on the basis of given information about properties
		Predict the properties of substances, given information that they are covalent molecular	

27. molecular formulae represent the number and type of atoms present in the molecules (refer to Appendix 2)	• Write the formulae for the molecular substances listed in appendix 2. • Given the systematic name, write the formula of a molecular compound.	**STAWA Stage 2 – Sets 8, 9 & 11**	
28. 28. 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	• Calculate the percentage composition by mass of a compound using its formula and a table of atomic masses.	**CWA1 – Chapter 6** **STAWA Stage 2 – Set 12** **Lucarelli (2AB) – Set 14**	

29. hydrocarbons, including alkanes, alkenes and benzene, have different chemical properties that are determined by the nature of the bonding within the molecules	• Identify alkanes and cycloalkanes as saturated hydrocarbons which only contain single bonds between carbon atoms and relate the chemical reactivity of alkanes to the presence of only single bonds. • Identify alkenes and cycloalkenes as unsaturated hydrocarbons which contain a double covalent bond and relate the chemical reactivity of alkenes to the presence of the double bond. • Describe the structure of benzene and relate the stability of its structure to the presence of delocalised electrons.	**CWA1 – Chapter 16** **Lucarelli – Chapter 14 (2AB)**	
30. molecular structural formulae (condensed or showing bonds) can be used to show the arrangement of atoms and bonding in covalent molecular substances	• Use the general formulae for the following homologous series to classify hydrocarbons: ○ Alkanes C_nH_{2n+2} ○ Cycloalkanes C_nH_{2n} ○ Alkenes C_nH_{2n} ○ Cycloalkenes C_nH_{2n-2} ○ Benzene C_6H_6 • Write the structural formulae for ○ Straight and branched chain alkanes (C_1 to C_8) ○ Simple cycloalkanes (C_3 to C_8) ○ Straight and branched chain alkenes (C_2 to C_8) ○ Simple cycloalkenes (C_3 to C_8) ○ Simple alkyl benzenes • Identify and write structures for structural isomers. • Identify and write structures for cis/trans geometric isomers.	**STAWA Stage 2 – Expt 29**	
31. IUPAC nomenclature is used to name straight and simple branched alkanes and alkenes from C1- C8	• Write the IUPAC names for ○ Straight and branched chain alkanes (C_1 to C_8) ○ Simple cycloalkanes (C_3 to C_8)	**STAWA Stage 2 – Sets 27-29**	

	○ Straight and branched chain alkenes (C_2 to C_8) ○ Simple cycloalkenes (C_3 to C_8) ○ Simple alkyl benzenes		
32. alkanes, alkenes and benzene undergo characteristic reactions such as combustion, addition reactions for alkenes and substitution reactions for alkanes and benzene	• Identify and write equations for the combustion of alkanes, alkenes and benzene in excess air to produce carbon dioxide and water. • Identify and write equations for the substitution reactions of alkanes and benzene with halogens. • Identify and write equations for the addition reactions of alkenes with hydrogen, halogens and hydrogen halides. • Distinguish between alkanes and alkenes by their reactions with halogens such as aqueous bromine solution.	Expt: Iodine substitution addition **STAWA Stage 2 – Invest 16 & 17**	**Test 4: Hydrocarbons**

Science as a Human Endeavour

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.

Science Understanding

Unit Content	Elaboration	Activities	Assessment opportunities
33. chemical reactions can be represented by	• Describe chemical reactions as processes in which substances called reactants are changed to different substances called products.	**CWA1 – Chapter 9** **Lucarelli – Chapters 2 & 3 (2AB)**	**Article of interest:** The future of

chemical equations; balanced chemical equations indicate the relative numbers of particles (atoms, molecules or ions) that are involved in the reaction	• Represent chemical reactions by equations which feature only those species consumed in the reaction and the new species produced, whether they be ions, molecules or solids. • Identify and use (s), (l), (g) and (aq), representing solid, liquid, gas and aqueous solution respectively in chemical equations. • Balance chemical equations for numbers of atoms and charge by using coefficients in front of the formulae in the equation. • State and apply that the relationship between the numbers of individual particles and also between the numbers of moles of particles in a reaction is shown by a balanced chemical equation.	**STAWA Stage 2 – Expt 12** **STAWA Stage 2 – Invest 11** **STAWA Stage 2 – Set 13** **STAWA Stage 2 – Expt 21** **STAWA Stage 2 – Set 21**	energy use and its implication to environmental science *Chemistry, Silberberg p.249*
34. chemical reactions and phase changes involve enthalpy changes, commonly observable as changes in the temperature of the surroundings and/or the emission of light	• Define the system and surroundings of a chemical reaction. • Distinguish between the system and the surroundings in a description of a chemical reaction. • State that chemical reactions are associated with the absorption or release of energy, commonly observable as changes in temperature and/or the emission of light.	**CWA1 – Chapter 10** **Lucarelli – Chapter 7 (2AB)** **STAWA Stage 2 – Expt 14** **STAWA Stage 2 – Invest 8**	**Test 2: Chemical Reactions**
35. endothermic and exothermic reactions can be explained in terms of the Law of Conservation of Energy and the breaking of existing bonds	• State that the Law of Conservation of Energy and describe how energy can be transformed during a chemical reaction. • State that energy is conserved between a reacting system and it surroundings during a chemical reaction. • Identify the enthalpy (H) of substances as stored chemical energy. • Determine the heat of reaction (ΔH) as the change in enthalpy between reactants and products. • Identify exothermic processes as those which release heat to the	Propose explanations, in terms of the types of bonds broken and formed, for the different energy changes observed during physical and chemical changes	

and forming of new bonds; heat energy released or absorbed by the system to or from the surroundings, can be represented in thermochemical equations	surroundings, and endothermic processes as those which absorb heat from the surroundings. • Write and interpret chemical equations which include the heat energy absorbed or released. • Identify exothermic reactions as those for which the heat of reaction is negative, and endothermic reactions are those for which the heat of reaction is positive. • Identify by observation exothermic and endothermic reactions. • Identify bonding breaking as an endothermic process and bond formation as an exothermic process. • Explain exothermic reactions in terms of the formation of more or stronger bonds than are broken and endothermic reactions in terms of the formation of fewer or weaker bonds that are broken.		
36. 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	• Calculate the energy output of fossil fuels (including coal, oil, petroleum and natural gas) and biofuels (including biogas, biodiesel and bioethanol) per unit mass and per mole. • Compare the energy output of fossil fuels and biofuels. • Identify the advantages and disadvantages of fossil fuels and biofuels in terms of combustion products, other environmental impacts and use. • Evaluate and justify fuel choice for a given situation.		**Invest. & Validation Test 3:** EC11-fossil fuel 2nd hand data

Science as a Human Endeavour 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.	• Identify the advantages and disadvantages of fossil fuels and biofuels in terms of combustion products, other environmental impacts and use. • Evaluate and justify fuel choice for a given situation	**www.vcaa.vic.edu.au/Documents/vce/chemistry/biofuelschemistry.doc** **STAWA Stage 2 – Expt 15** 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	
37. the mole is a precisely defined quantity of matter equal Avogadro's number of particles	• Define the mole as being Avogadro's number of particles (6.022 x 10^{23}). • Define the molar mass of a substance as the mass of Avogadro's number of particles of the substance. • State and apply that molar masses are equal to atomic, molecular and formula masses expressed in grams. • Solve problems involving the number of moles and number of particles (application of n=(*number of atoms*)/(6.022 *x* 10-^23))	**CWA1 – Chapter 6** **Lucarelli – Chapter 9 (2AB)** **STAWA Stage 2 – Expt 13** **STAWA Stage 2 – Set 9-11, 14, 17** **Lucarelli (2AB) – Set 13**	**Practical and Validation Test 2** – EF of MgO (Modify STAWA Expt 10)

38. 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	• Calculate the molar mass of a substance. • Solve problems involving the number of moles, mass and molar mass of a substance. • State and apply that mass, atoms and charge are conserved during a chemical reaction. • Perform mass/mass calculations with the mole as the unifying concept.	**STAWA Stage 2 – Invest 5** **STAWA Stage 2 – Set 16**	
39. 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	• Given the formula, determine the amount in mole of each element present in a given substance • Given the formula, determine the mass of each element present in a given mass of the substance • Calculate the percentage composition of a compound, given the mass of each element in a given mass of the compound • Calculate percentage composition by mass from chemical formulas	**STAWA Stage 2 – Set 12**	