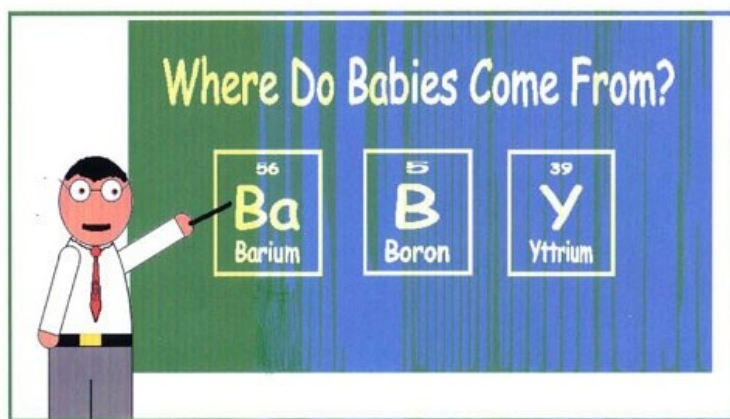# Chemistry
Units 1 and 2

(NA, 2011)

Due to budget cuts, science and health were both taught by the chemistry teacher! (Colleen, 2007)

2020

Year 11 Chemistry Unit 1 and 2

Many students find the transition from lower school to upper school quite difficult. The material is presented at a faster pace and there is more responsibility on your part to keep up by regularly studying at home. Many students in the past have said that they wished they had studied harder **from the beginning of the year.**

Here are some suggestions to help you achieve your best.

1. **Use class time effectively**. This will help reduce pressure on your workload at home and help you to be better prepared for assessments.

   a. Always bring your textbook and current topic booklet to class.
   b. Pay attention.
   c. Trying to answer questions asked by the teacher.
   d. Listen to other students' answers and the teachers response to them (a lot of misconceptions are cleared up this way).
   e. Be prepared to ask questions.
   f. Be prepared to ask for help – there is tutoring available or you can make an appointment to see your teacher.
   g. Always aim to work within time constraints as this will prepare you well for the time constraints faced in assessments.
   h. Work as quickly and accurately as possible in practical sessions. Keep accurate records of your results, regardless of whether it is for assessment.

2. **Get organised**.
   a. Have a master file for filing your notes and worksheets, set up topic by topic. After each topic put your notes into the master file and keep the topics separated by dividers.
   b. Fill in all assessment dates onto a master schedule so you can see what is coming up and plan ahead for it.

3. **Join a study group.** Some of the most successful Chemistry classes have organised themselves into efficient and serious study groups. Learning from each other and teaching each other helps to reinforce all the concepts and contexts that you will encounter.

4. **Practice Calculations.** Knowing and being able to follow the processes for calculations is half the battle in this section of the course.

5. **Spend time at home each day for consolidation/study.** Suggested things to do are:

   a. Read over the work covered in class that day – your notes and text book- and make dot point summaries.
   b. Copy new words into your definitions book
   c. While reading through your notes jot down anything you don't understand and make sure you ask for help the next day.
   d. Review the work to date on the topic, trying to link concepts and information together
   e. Test yourself on the work to date. Your revision book is helpful for doing this.
   f. Use mindmaps to summarise topics and to show links between concepts.
   g. Use flashcards for rote learning (eg ions, reaction types and fundamental concepts).

ASSESSMENT OUTLINE- 2020
CHEMISTRY ATAR Y11
UNITS 1 AND 2

Assessment type (from syllabus)	Assessment type weighting	Assessment task weighting	When	Assessment task
Practical and Investigation	**25%**	6.5%	T2: Week 2	**Task 6:** Post laboratory test 1 on- Spectrscopes, Flame tests, Electrical conductivity of substances, Reactivity of hydrocarbons
		6.5%	T3: Week 7	**Task 11:** Post laboratory test 2 on- Reaction rate and concentration/ temperature, Intermolecular forces in alcohols
		6%	T1: Week 6	**Task 3:** Determining the Waters of Crystallisation of an unknown salt.
		6%	T3: Week 8	**Task 12:** Using chromatography to analyse the strength of intermolecular forces in various colours of ink.
Extended response	**10%**	5%	T1: Week 3	**Task 1:** Extended response 1 - Discovery of the atom.
		5%	T2: Week 9	**Task 8:** Extended response 2- Energy and CO_2 output for fossil fuels and biofuels
Test	**15%**	2%	T1: Week 4	**Task 2:** Properties and Structure of Atoms
		1.5%	T1: Week 8	**Task 4:** Properties and Structure of Materials: Bonding
		2.5%	T2: Week 1	**Task 5:** Properties and Structure of Materials: Organic Chemistry
		2%	T2: Week 10	**Task 9:** Chemical Reactions: Reactants, Products and Energy Change
		2%	T3: Week 3	**Task 10:** Rates of Chemical Reactions
		2%	T3: Week 9	**Task 13:** Intermolecular Forces and Gases
		3%	T4: Week 3	**Task 14:** Aqueous Solutions and Acidity
Examination	**50%**	15%	T2: Week 6-7	**Task 7:** Semester 1 examination – Covers Unit 1 content
		35%	T4: Week 5-6	**Task 15:** Semester 2 examination – Covers Unit 1 and 2 content
Total	**100%**	**100%**		

ASSESSMENTS

1. **Assessment types and weightings:**

Assessment Type	Weighting (%)
Practical Assessments and Investigations	25
Extended response	10
Tests	15
Examinations	50

2. **Exam format:** Exams are set according to the format set out by the School Curriculum and Standards Authority:

Multiple Choice	25%
Short Answers	35%
Extended Response	40%

3. **Practical assessments and investigations:**

Most topics involve some kind of practical assessment based on laboratory work. These may be either:

(i) Pre-lab and post-lab validation tests: These will be given before a lab and after any practical class.

(ii) Report Write Up: Refer to the page for instructions on how to write a Chemistry Lab Report. Reports are to be written up fully and kept in your file.

(iii) Practical skills: A component of your mark will be awarded for your practical skills.

4. **Test assessments:**

Tests are given at the conclusion of each topic, using the unit content objectives set out by the School Curriculum and Standards Authority.

5. **All assessments:**

These will be retained by your teacher but made available for revision purposes. **Assessments may not be taken home.**

1. **Title**: The relationship between the independent and dependent variable.

2. **Aim**: To investigate the relationship between the independent and dependent variable.

3. **Hypothesis**: An educated guess, which is in the form of a single statement that can be tested and must include the dependent and independent variables.

4. **Variables**: Any factor that can influence the outcome of the investigation.

   - Independent – the variable that will be deliberately changed.
   - Dependent – the variable that will be measured (this variable changes in response to the independent variable being changed.)
   - Controlled – variables that are not tested but could potentially influence the outcome of the investigation. They should be kept the same.

5. **Materials**: The list of equipment that is needed.

6. **Safety and Ethical Considerations:** A list of any safety and ethical measures that must be considered.

7. **Method**: A step-by-step account of how the experiment was performed.

   Each new step must be on a new line (it reads like a cooking recipe, not like a paragraph). Where appropriate, include a labelled scientific diagram of the apparatus. Include:
   - measurements, controlled variables and repeat trials.
   - control group, if applicable. It is the same in every way to the experimental group except that the independent variable is absent. The control group allows a comparison to be made.

8. **Results**: This is the data collected and it is always recorded in a table.

   The independent variable must be on the left-hand column and the dependent variable must be on the top row of the table.

   Results should be graphed. When graphing results, only the ***averages*** should be graphed, not every trial. On the graph, the independent variable goes on the horizontal (**X**) axis and the dependent variable goes on the vertical (**Y**) axis.

9. **Discussion**:

   - What happened (i.e. what were the results)? Include trends and patterns in the results.
   - Why did this happen (i.e. explain the results using scientific knowledge and research)?

10. **Evaluation:** Discuss problems that were encountered in the investigation.

   Include scientific problems only, not problems with group members. No experiment is ever one hundred percent problem-free (think critically about these). Consider the following aspects:

   - **Validity:** Was the correct variable tested? (in aim) Are all variables that could influence the outcome of the investigation been fully controlled?
   - **Reliability:** Replication and repetition to eliminate outliers. Has an average been calculated?
   - **Accuracy:** Are the values of the measurements taken accurate? Was the correct equipment used? Was the equipment used correctly?

   Taking into account the evaluation, how could the experiment be improved if it were done again?

11. **Conclusion**: This should be a two-sentence section where the results are restated. State if the <u>results support or refute the hypothesis</u>.

A scientific report must ***never*** have personal pronouns (e.g. I, he, she, we, they, etc.) or proper nouns (e.g. Sherri, Jack, Fido, etc.).

COURSE OUTLINE- 2020

Chemistry- ATAR Year 11
Units 1 and 2

WEEK	TOPIC	KEY TEACHING POINTS
Term 1 Week 1-5	Properties and structure of atoms	• 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
		• 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
		• 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
		• 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
		• 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
		• molecular formulae represent the number and type of atoms present in the
		• 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 (empirical formula by percentage composition).
		Task 1: Extended response - Discovery of the atom (T1: Week 3)
		Task 2: Test- Properties and Structure of Atoms (T1: Week 4)
		Task 3: Investigation- Determining the waters of crystallisation of an unknown salt (T1: Week 6)
Term 1		• materials are pure substances with distinct measurable properties,

Week 6-7	Properties and structure of materials: bonding	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
		• 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
		• differences in the physical properties of substances in a mixture, including particle size, solubility, density, and boiling point, can be used to separate them
		• 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
		• 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)
		• 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 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
		• 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
		• elemental carbon exists as a range of allotropes, including graphite, diamond and fullerenes, with significantly different structures and physical properties
Term 1 Week 8-9	Properties and structure of materials: organic chemistry	**Task 4: Test- Properties and Structure of Materials: Bonding (T1: Week 8)** • 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 alkenes and substitution reactions for alkanes and benzene
Week 10	Y11 Camp	
Term 2 Week 1	Properties and structure of materials: organic chemistry	• alkanes, alkenes and benzene undergo characteristic reactions such as combustion, addition reactions for alkenes and substitution reactions for alkanes and benzene **completed** **Task 5: Test- Properties and Structure of Materials: Organic Chemistry (T2: Week 1)**
Term 2 Week 2-4	Chemical reactions: reactants, products and energy change	**Task 6: Practical test- Post laboratory test 1 on: Spectroscopes, Flame tests, Electrical conductivity of substances, Reactivity of hydrocarbons (T2: Week 2)** • 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 • chemical reactions and phase changes involve enthalpy changes, commonly observable as changes in the temperature of the surroundings and/or the emission of 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 • empirical formula can be determined using percentage composition, mass

		composition and combustion data.
		• the mole is a precisely defined quantity of matter equal to Avogadro's number of particles
		• 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
		• the limiting reagent in a chemical reaction can be determined using masses and moles of reactants.
Term 2 Week 5	Revision	Examination revision
Term 2 Week 6-7	Exams	**Task 7: Examination- Semester 1**
Term 2 Week 8-10	Chemical reactions: reactants, products and energy change.	• 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 **Task 8: Extended response 2- Energy and CO_2 output for fossil fuels and biofuels (T2: Week 9)** **Task 9: Test- Chemical Reactions: Reactants, Products and Energy Change (T2: Week 10)**
Term 3 Week 1- 2	Rates of chemical reactions	• varying the conditions under which chemical reactions occur can affect the rate of the reaction
		• the rate of chemical reactions can be quantified by measuring the rate of formation of products or the depletion of reactants
		• 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
Term 3 Week 3-8	Intermolecular forces and gases	**Task 10: Test- Rates of Chemical Reactions (T3: Week 3)**
		• 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

		• 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), 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
		• 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 substances and volume of gases (at standard temperature and pressure) involved in a chemical reaction
		Task 11 : Practical test- Post laboratory test 2 on: Reaction rate and concentration/ temperature, Intermolecular forces in alcohols (T3: Week 7)
		Task 12: Investigation- Using chromatography to analyse the strength of intermolecular forces in various colours of ink. (T3: Week 8)
		Task 13: Test- Intermolecular forces and gases (T3: Week 9)
Term 3 Week 9 - Term 4 Week 3	Aqueous solutions and acidity	• 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)
		• 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
		• 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 temperature
		• 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
		• pH is used as a measure of the acidity of solutions and is dependent on the concentration of hydrogen ions in the solution
		• 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 and products in these reactions
		• the mole concept can be used to calculate the mass of solute, and solution concentrations and volumes involved in a chemical reaction
		Task 14: Test- Aqueous solutions and acidity (T4: Week 3)
Term 4 Week 4	Revision	Examination revision
Term 4 Week 5-6	Exams	**Task 15: Examination- Semester 2**

Rationale

Chemistry is the study of materials and substances and the transformations they undergo through interactions and the transfer of energy. Chemists can use an understanding of chemical structures and processes to adapt, control and manipulate systems to meet particular economic, environmental and social needs. This includes addressing the global challenges of climate change and security of water, food and energy supplies, and designing processes to maximise the efficient use of Earth's finite resources. Chemistry develops students' understanding of the key chemical concepts and models of structure, bonding, and chemical change, including the role of chemical, electrical and thermal energy. Students learn how models of structure and bonding enable chemists to predict properties and reactions and to adapt these for particular purposes.

Students explore key concepts and models through active inquiry into phenomena and through contexts that exemplify the role of chemistry and chemists in society. Students design and conduct qualitative and quantitative investigations both individually and collaboratively. They investigate questions and hypotheses, manipulate variables, analyse data, evaluate claims, solve problems and develop and communicate evidence-based arguments and models. Thinking in chemistry involves using differing scales, including
macro, micro and nano-scales; using specialised representations such as chemical symbols and equations; and being creative when designing new materials or models of chemical systems. The study of chemistry provides a foundation for undertaking investigations in a wide range of scientific fields and often provides the unifying link across interdisciplinary studies.

Some of the major challenges and opportunities facing Australia and the Asia-Pacific region at the beginning of the twenty-first century are inextricably associated with chemistry. Issues of sustainability on local, national and global levels are, and will continue to be, tackled by the application of chemical knowledge using a range of technologies. These include issues such as the supply of clean drinking water, efficient production and use of energy, management of mineral resources, increasing acidification of the oceans, and climate change.

Studying Chemistry provides students with a suite of skills and understandings that are valuable to a wide range of further study pathways and careers. An understanding of chemistry is relevant to a range of careers, including those in forensic science, environmental science, engineering, medicine, dentistry, pharmacy and sports science. Additionally, chemistry knowledge is valuable in occupations that rely on an understanding of materials and their interactions, such as art, winemaking, agriculture and food technology. Some students will use this course as a foundation to pursue further studies in chemistry, and all students will become more informed citizens, able to use chemical knowledge to inform evidence-based decision making and engage critically with contemporary scientific issues.

Aims

The Chemistry ATAR course aims to develop students':

- interest in and appreciation of chemistry and its usefulness in helping to explain phenomena and solve problems encountered in their ever-changing world

- understanding of the theories and models used to describe, explain and make predictions about chemical systems, structures and properties

- understanding of the factors that affect chemical systems, and how chemical systems can be controlled to produce desired products

- appreciation of chemistry as an experimental science that has developed through independent and collaborative research, and that has significant impacts on society and implications for decision making

- expertise in conducting a range of scientific investigations, including the collection and analysis of qualitative and quantitative data and the interpretation of evidence

- ability to critically evaluate and debate scientific arguments and claims in order to solve problems and generate informed, responsible and ethical conclusions

- ability to communicate chemical understanding and findings to a range of audiences, including through the use of appropriate representations, language and nomenclature.

Organisation

This course is organised into a Year 11 syllabus and a Year 12 syllabus. The cognitive complexity of the syllabus content increases from Year 11 to Year 12.

Structure of the syllabus

The Year 11 syllabus is divided into two units, each of one semester duration, which are typically delivered as a pair. The notional time for each unit is 55 class contact hours.

Unit 1 – Chemical fundamentals: structure, properties and reactions

In this unit, students use models of atomic structure and bonding to explain the macroscopic properties of materials. Students develop their understanding of the energy changes associated with chemical reactions and the use of chemical equations to calculate the masses of substances involved in chemical reactions.

Unit 2 – Molecular interactions and reactions

In this unit, students continue to develop their understanding of bonding models and the relationship between structure, properties and reactions, including consideration of the factors that affect the rate of chemical reactions. Students investigate the unique properties of water and the properties of acids and bases, and use chemical equations to calculate the concentrations and volumes of solutions involved in chemical reactions.

Each unit includes:
- a unit description – a short description of the focus of the unit
- learning outcomes – a set of statements describing the learning expected as a result of studying the unit
- unit content – the content to be taught and learned.

Organisation of content

Science strand descriptions

The Chemistry ATAR course has three interrelated strands: Science Inquiry Skills, Science as a Human Endeavour and Science Understanding which build on students' learning in the Year 7–10 Science curriculum. The three strands of the Chemistry ATAR course should be taught in an integrated way. The content descriptions for Science Inquiry Skills, Science as a Human Endeavour and Science Understanding have been written so that this integration is possible in each unit.

Science Inquiry Skills

Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting data; and communicating findings. This strand is concerned with evaluating claims, investigating ideas, solving problems, reasoning, drawing valid conclusions, and developing evidence-based arguments.

Science investigations are activities in which ideas, predictions or hypotheses are tested and conclusions are drawn in response to a question or problem. Investigations can involve a range of activities, including experimental testing, field work, locating and using information sources, conducting surveys, and using modelling and simulations.

In science investigations, the collection and analysis of data to provide evidence plays a major role. This can involve collecting or extracting information and reorganising data in the form of tables, graphs, flow charts, diagrams, text, keys, spreadsheets and databases. The analysis of data to identify and select evidence, and the communication of findings, involve the selection, construction and use of specific representations, including mathematical relationships, symbols and diagrams.

Through the Chemistry ATAR course, students will continue to develop their science inquiry skills, building on the skills acquired in the Year 7–10 Science curriculum. Each unit provides specific skills to be taught. These specific skills align with the Science Understanding and Science as a Human Endeavour content of the unit.

Science as a Human Endeavour

Through science, we seek to improve our understanding and explanations of the natural world. The Science as a Human Endeavour strand highlights the development of science as a unique way of knowing and doing, and explores the use and influence of science in society.

As science involves the construction of explanations based on evidence, the development of science concepts, models and theories is dynamic and involves critique and uncertainty. Science concepts, models and theories are reviewed as their predictions and explanations are continually re-assessed through new evidence, often through the application of new technologies. This review process involves a diverse range of scientists working within an increasingly global community of practice and can involve the use of international conventions and activities such as peer review.

The use and influence of science are shaped by interactions between science and a wide range of social, economic, ethical and cultural factors. The application of science may provide great benefits to individuals, the community and the environment, but may also pose risks and have unintended consequences. As a result, decision making about socio-scientific issues often involves consideration of multiple lines of evidence and a range of stakeholder needs and values. As an ever-evolving body of knowledge, science frequently informs public debate, but is not always able to provide definitive answers.

Science Understanding

Science understanding is evident when a person selects and integrates appropriate science concepts, models and theories to explain and predict phenomena, and applies those concepts, models and theories to new situations. Models in science can include diagrams, physical replicas, mathematical representations,
word-based analogies (including laws and principles) and computer simulations. Development of models involves selection of the aspects of the system(s) to be included in the model, and thus models have inherent approximations, assumptions and limitations.

The Science Understanding content in each unit develops students' understanding of the key concepts, models and theories that underpin the subject, and of the strengths and limitations of different models and theories for explaining and predicting complex phenomena. In addition the following objectives will need to be mastered in order to pass this course.

Science Inquiry Skills

- identify, research and refine questions for investigation; propose hypotheses; and predict possible outcomes

- 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 and heat of reaction

- 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

- 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

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

Safety

Science learning experiences may involve the use of potentially hazardous substances and/or hazardous equipment. It is the responsibility of the school to ensure that duty of care is exercised in

relation to the health and safety of all students and that school practices meet the requirements of the *Work Health and Safety Act 2011,* in addition to relevant State health and safety guidelines.

Mathematical skills expected of students studying the Chemistry ATAR course

The Chemistry ATAR course requires students to use the mathematical skills they have developed through the Year 7–10 Mathematics curriculum, in addition to the numeracy skills they have developed through the Science Inquiry Skills strand of the Science curriculum.

Within the Science Inquiry Skills strand, students are required to gather, represent and analyse numerical data to identify the evidence that forms the basis of their scientific arguments, claims or conclusions. In gathering and recording numerical data, students are required to make measurements with an appropriate degree of accuracy and to represent measurements using appropriate units.

Students may need to be taught when it is appropriate to join points on a graph and when it is appropriate to use a line of best fit. They may also need to be taught how to construct a straight line that will serve as the line of best fit for a set of data presented graphically.

It is assumed that students will be able to:

- perform calculations involving addition, subtraction, multiplication and division of quantities

- perform approximate evaluations of numerical expressions

- express fractions as percentages, and percentages as fractions

- calculate percentages

- recognise and use ratios

- transform decimal notation to power of ten notation

- change the subject of a simple equation

- substitute physical quantities into an equation using consistent units so as to calculate one quantity and check the dimensional consistency of such calculations

- solve simple algebraic equations

- comprehend and use the symbols/notations $<$, $>$, Δ, $\approx$

- translate information between graphical, numerical and algebraic forms

- distinguish between discrete and continuous data and then select appropriate forms, variables and scales for constructing graphs

- construct and interpret frequency tables and diagrams, pie charts and histograms

- describe and compare data sets using mean, median and inter-quartile range

- interpret the slope of a linear graph.

School-based assessment

The Western Australian Certificate of Education (WACE) Manual contains essential information on principles, policies and procedures for school-based assessment that needs to be read in conjunction with this syllabus.

Teachers design school-based assessment tasks to meet the needs of students. The table below provides details of the assessment types for the Chemistry ATAR Year 11 syllabus and the weighting for each assessment type.

Assessment table – Year 11

Type of assessment	Weighting
Science inquiry Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting data; and communicating findings. **Practical** Practical work can involve a range of activities, such as practical tests; modelling and simulations; qualitative and/or quantitative analysis of second-hand data; and brief summaries of practical activities. **Investigation** Investigations are more extensive activities, which can include experimental testing; chemical analyses; and comprehensive scientific reports. The assessed component of tasks of these types should be conducted in a supervised classroom setting. Students must complete at least one investigation in each unit.	25%
Extended response Tasks requiring an extended response can involve selecting and integrating appropriate science concepts, models and theories to explain and predict phenomena, and applying those concepts, models and theories to new situations; interpreting scientific and media texts and evaluating processes, claims and conclusions by considering the quality of available evidence; and using reasoning to construct scientific arguments. Assessment can take the form of answers to specific questions based on individual research and interpretation and evaluation of chemical information in scientific journals, media texts and/or advertising. Appropriate strategies should be used to authenticate student achievement on an out-of-class assessment task. For example, research completed out of class can be authenticated using an in-class assessment task under test conditions.	10%
Test Tests are structured tasks designed so that students can apply their understanding and skills in chemistry to analyse, interpret, solve problems and construct scientific arguments.	15%
Examination Typically conducted at the end of each semester and/or unit. In preparation for Unit 3 and Unit 4, the examination should reflect the examination design brief included in the ATAR Year 12 syllabus for this course.	50%

Teachers are required to use the assessment table to develop an assessment outline for the pair of units (or for a single unit where only one is being studied).

The assessment outline must:

- include a set of assessment tasks

- include a general description of each task

- indicate the unit content to be assessed

- indicate a weighting for each task and each assessment type

- include the approximate timing of each task (for example, the week the task is conducted, or the issue and submission dates for an extended task).

In the assessment outline for the pair of units, each assessment type must be included at least twice. In the assessment outline where a single unit is being studied, each assessment type must be included at least once.

The set of assessment tasks must provide a representative sampling of the content for Unit 1 and Unit 2.

Assessment tasks not administered under test/controlled conditions require appropriate validation/authentication processes.

Grading

Schools report student achievement in terms of the following grades:

Grade	Interpretation
A	Excellent achievement
B	High achievement
C	Satisfactory achievement
D	Limited achievement
E	Very low achievement

The teacher prepares a ranked list and assigns the student a grade for the pair of units (or for a unit where only one unit is being studied). The grade is based on the student's overall performance as judged by reference to a set of pre-determined standards. These standards are defined by grade descriptions and annotated work samples. The grade descriptions for the Chemistry ATAR Year 11 syllabus are provided in Appendix 1. They can also be accessed, together with annotated work samples, through the Guide to Grades link on the course page of the Authority website at www.scsa.wa.edu.au

To be assigned a grade, a student must have had the opportunity to complete the education program, including the assessment program (unless the school accepts that there are exceptional and justifiable circumstances).

Refer to the WACE Manual for further information about the use of a ranked list in the process of assigning grades.

Appendix 1 – Grade descriptions Year 11

A	**Understanding and applying concepts** Applies chemical principles to explain complex phenomena, for example, factors affecting reaction rates. Explains the physical properties of substances in terms of their bonding type. Uses chemical formulae, equations and structures to solve problems and/or to support a point of view. Applies mathematical procedures that may involve rearranging formulae to solve complex problems.
	Investigation skills Independently designs, conducts and critically evaluates investigations. Selects, interprets, manipulates, and critically analyses data/information. Independently selects, and safely manipulates, appropriate apparatus and materials to obtain accurate results.
	Communication skills Communicates detailed information and concepts logically and coherently. Uses correct terminology and conventions, including chemical formulae and equations. Constructs a clearly labelled graph from the data provided, and interprets the graph to solve problems.

B	**Understanding and applying concepts** Applies chemical concepts to accurately explain simple, and some complex, phenomena. Links the physical properties of substances to their bonding types and illustrates these using appropriate diagrams. Uses chemical formulae and balanced equations to solve some problems and support a point of view. Solves multi-step calculations with only minor inaccuracies.
	Investigation skills Using minimal scaffolding, designs, conducts and evaluates investigations. Selects, interprets, manipulates and analyses data/information. Independently selects, and safely manipulates, appropriate apparatus and materials.
	Communication skills Communicates information and concepts logically using correct terminology and conventions, for example, chemical formulae and equations. Constructs clearly labelled graphs from the data provided.

C	**Understanding and applying concepts** Inconsistently applies chemical concepts to describe phenomena. Explanations lack detail. Responses lack detail and include irrelevant information. Describes concepts, for example, chemical reactions, in general terms and predicts the observations for a reaction. Inconsistently uses chemical formulae, equations and structures. Uses given formulae to solve straightforward problems.
	Investigation skills Using scaffolding, designs and conducts investigations with evidence of basic evaluation. Selects, interprets and manipulates data/information. Independently selects some appropriate apparatus and materials and uses them safely.
	Communication skills Communicates information without detail, using some correct terminology and conventions, for example, chemical formulae and equations. Constructs clearly labelled graphs from the data provided.

D	**Understanding and applying concepts**
	Incorrectly applies chemical principles to explain properties and phenomena.
	Classifies compounds according to their bonding type without explaining their properties.
	Correctly solves simple calculations.
	Investigation skills
	With guidance, designs and conducts investigations.
	With guidance, selects appropriate apparatus and materials and uses them safely.
	Manipulates simple data/information, with errors in application of conventions.
	Communication skills
	Communicates information using simple terminology, but with frequent errors in use of conventions,
	for example, chemical formulae and equations.
	Constructs graphs which include many errors.

E	Does not meet the requirements of a D grade.

Appendix 2

Students should be able to recognise and write the formula of the following ions and molecules:

Ion name	Formula
ammonium	NH_4^+
caesium	Cs^+
hydrogen	H^+
lithium	Li^+
potassium	K^+
rubidium	Rb^+
silver	Ag^+
sodium	Na^+
barium	Ba^{2+}
calcium	Ca^{2+}
cobalt(II)	Co^{2+}
copper(II)	Cu^{2+}
iron(II)	Fe^{2+}
lead(II)	Pb^{2+}
magnesium	Mg^{2+}
manganese(II)	Mn^{2+}
nickel(II)	Ni^{2+}
strontium	Sr^{2+}
zinc	Zn^{2+}
aluminium	Al^{3+}
chromium(III)	Cr^{3+}
iron(III)	Fe^{3+}

Ion name	Formula
bromide	Br^-
chloride	Cl^-
cyanide	CN^-
dihydrogenphosphate	$H_2PO_4^-$
ethanoate (acetate)	CH_3COO^-
fluoride	F^-
hydrogencarbonate	HCO_3^-
hydrogensulfate	HSO_4^-
hydroxide	OH^-
iodide	I^-
nitrate	NO_3^-
nitrite	NO_2^-
permanganate	MnO_4^-
carbonate	CO_3^{2-}
chromate	CrO_4^{2-}
dichromate	$Cr_2O_7^{2-}$
hydrogenphosphate	HPO_4^{2-}
oxalate	$C_2O_4^{2-}$
oxide	O^{2-}
sulfate	SO_4^{2-}
sulfide	S^{2-}
sulfite	SO_3^{2-}
nitride	N^{3-}
phosphate	PO_4^{3-}

Common molecules that have non-systematic names:

Molecule name	Formula
ammonia	NH_3
water	H_2O
hydrogen peroxide	H_2O_2
ethanoic acid	CH_3COOH
hydrochloric acid	HCl
nitric acid	HNO_3
carbonic acid	H_2CO_3
sulfuric acid	H_2SO_4
sulfurous acid	H_2SO_3
phosphoric acid	H_3PO_4

Appendix 3 – Glossary

This glossary is provided to enable a common understanding of the key terms in this syllabus.

Algebraic representation	A set of symbols linked by mathematical operations; the set of symbols summarise relationships between variables.
Anomalous data	Data that does not fit a pattern; outlier.
Data	The plural of datum; the measurement of an attribute, for example, the volume of gas or the type of rubber. This does not necessarily mean a single measurement: it may be the result of averaging several repeated measurements. Data may be quantitative or qualitative and be from primary or secondary sources.
Evidence	In science, evidence is data that is considered reliable and valid and which can be used to support a particular idea, conclusion or decision. Evidence gives weight or value to data by considering its credibility, acceptance, bias, status, appropriateness and reasonableness.
Genre	The categories into which texts are grouped; genre distinguishes texts on the basis of their subject matter, form and structure (for example, scientific reports, field guides, explanations, procedures, biographies, media articles, persuasive texts, narratives).
Green chemistry	Chemistry that aims to design products and processes that minimise the use and generation of hazardous substances and wastes. Principles of green chemistry include prevention of waste; atom economy; design of less toxic chemicals and synthesis methods; use of safer solvents and auxiliaries; design for energy efficiency; use of renewable feedstocks; reduction of unnecessary derivatives; use of catalytic reagents rather than stoichiometric reagents; design for degradation; design of in-process analysis for pollution prevention; and safer chemistry for accident prevention.
Hypothesis	A tentative explanation for an observed phenomenon, expressed as a precise and unambiguous statement that can be supported or refuted by experiment.
Investigation	A scientific process of answering a question, exploring an idea or solving a problem that requires activities such as planning a course of action, collecting data, interpreting data, reaching a conclusion and communicating these activities. Investigations can include observation, research, field work, laboratory experimentation and manipulation of simulations.
Law	A statement describing invariable relationships between phenomena in specified conditions, frequently expressed mathematically.
Measurement error	The difference between the measurement result and a currently accepted or standard value of a quantity.

Media texts	Spoken, print, graphic or electronic communications with a public audience. Media texts can be found in newspapers, magazines and on television, film, radio, computer software and the internet.
Mode	The various processes of communication – listening, speaking, reading/viewing and writing/creating.
Model	A representation that describes, simplifies, clarifies or provides an explanation of the workings, structure or relationships within an object, system or idea.
Primary data	Data collected directly by a person or group.
Primary source	Report of data created by the person or persons directly involved in observations of one or more events, experiments, investigations or projects.
Random error	Uncontrollable effects of the measurement equipment, procedure and environment on a measurement result; the magnitude of random error for a measurement result can be estimated by finding the spread of values around the average of independent, repeated measurements of the quantity.
Reliable data	Data that has been judged to have a high level of reliability; reliability is the degree to which an assessment instrument or protocol consistently and repeatedly measures an attribute, achieving similar results for the same population.
Reliability	The degree to which an assessment instrument or protocol consistently and repeatedly measures an attribute, achieving similar results for the same population.
Representation	A verbal, visual, physical or mathematical demonstration of understanding of a science concept or concepts. A concept can be represented in a range of ways and using multiple modes.
Research	To locate, gather, record, attribute and analyse information in order to develop understanding.
Research ethics	Norms of conduct that determine ethical research behavior; research ethics are governed by principles such as honesty, objectivity, integrity, openness and respect for intellectual property and include consideration of animal ethics.
Risk assessment	Evaluations performed to identify, assess and control hazards in a systematic way that is consistent, relevant and applicable to all school activities. Requirements for risk assessments related to particular activities will be determined by jurisdictions, schools or teachers as appropriate.
Secondary data	Data collected by a person or group other than the person or group using the data.
Secondary source	Information that has been compiled from records of primary sources by a person or persons not directly involved in the primary event.

Significant figures	The use of place value to represent a measurement result accurately and precisely.
Simulation	A representation of a process, event or system which imitates a real or idealised situation.
System	A group of interacting objects, materials or processes that form an integrated whole. Systems can be open or closed.
Systematic error	The contribution to the uncertainty in a measurement result that is identifiable and quantifiable, for example, imperfect calibration of measurement instruments.
Theory	A set of concepts, claims and/or laws that can be used to explain and predict a wide range of related observed or observable phenomena. Theories are typically founded on clearly identified assumptions, are testable, produce reproducible results and have explanatory power.
Uncertainty	Range of values for a measurement result, taking account of the likely values that could be attributed to the measurement result given the measurement equipment, procedure and environment.
Validity	The extent to which tests measure what was intended; the extent to which data, inferences and actions produced from tests and other processes are accurate.

Bibliography

NA, 2011: , (NA, 2011),