Unit 1: How can the diversity of materials be explained?

The development and use of materials for specific purposes is an important human endeavour. In this unit students investigate the chemical properties of a range of materials from metals and salts to polymers and nanomaterials. Using their knowledge of elements and atomic structure students explore and explain the relationships between properties, structure and bonding forces within and between particles that vary in size from the visible, through nanoparticles, to molecules and atoms.

Students examine the modification of metals, assess the factors that affect the formation of ionic crystals and investigate a range of non-metallic substances from molecules to polymers and giant lattices and relate their structures to specific applications.

Students are introduced to quantitative concepts in chemistry including the mole concept. They apply their knowledge to determine the relative masses of elements and the composition of substances. Throughout the unit students use chemistry terminology including symbols, formulas, chemical nomenclature and equations to represent and explain observations and data from experiments, and to discuss chemical phenomena.

A research investigation is undertaken in Area of Study 3 related to one of ten options that draw upon and extend the content from Area of Study 1 and/or Area of Study 2.

Area of Study 1

How can knowledge of elements explain the properties of matter?

In this area of study students focus on the nature of chemical elements, their atomic structure and their place in the periodic table. They review how the model of the atom has changed over time and consider how spectral evidence led to the Bohr model and subsequently to the Schrödinger model. Students examine the periodic table as a unifying framework into which elements are placed based upon similarities in their electronic configurations. In this context students explore patterns and trends of, and relationships between, elements with reference to properties of the elements including their chemical reactivity.

Students investigate the nature of metals and their properties, including metallic nanomaterials. They investigate how a metal is extracted from its ore and how the properties of metals may be modified for a particular use. Students apply their knowledge of the electronic structures of metallic elements and non-metallic elements to examine ionic compounds. They study how ionic compounds are formed, explore their crystalline structures and investigate how changing environmental conditions may change their properties.

Fundamental quantitative aspects of chemistry are introduced including the mole concept, relative atomic mass, percentage abundance and composition by mass and the empirical formula of an ionic compound.

Outcome 1

On completion of this unit the student should be able to relate the position of elements in the periodic table to their properties, investigate the structures and properties of metals and ionic compounds, and calculate mole quantities.

To achieve this outcome the student will draw on key knowledge outlined in Area of Study 1 and the related key skills on pages 10 and 11 of the study design.

Key knowledge

Elements and the periodic table

- the relative and absolute sizes of particles that are visible and invisible to the unaided eye: small and giant molecules and lattices; atoms and sub-atomic particles; nanoparticles and nanostructures
- the definition of an element with reference to atomic number; mass number; isotopic forms of an element using appropriate notation
- spectral evidence for the Bohr model and for its refinement as the Schrödinger model; electronic configurations of elements 1 to 36 using the Schrödinger model of the atom, including s, p, d and f notations (with copper and chromium exceptions)
- the periodic table as an organisational tool to identify patterns and trends in, and relationships between, the structures (including electronic configurations and atomic radii) and properties (including electronegativity, first ionisation energy, metallic/non-metallic character and reactivity) of elements.

Metals

- the common properties of metals (lustre, malleability, ductility, heat and electrical conductivity) with reference to the nature of metallic bonding and the structure of metallic crystals, including limitations of representations; general differences between properties of main group and transition group metals
- experimental determination of the relative reactivity of metals with water, acids and oxygen
- the extraction of a selected metal from its ore/s including relevant environmental, economic and social issues associated with its extraction and use
- experimental modification of a selected metal related to the use of coatings or heat treatment or alloy production
- properties and uses of metallic nanomaterials and their different nanoforms including comparison with the properties of their corresponding bulk materials.

Ionic compounds

- common properties of ionic compounds (brittleness, hardness, high melting point, difference in electrical conductivity in solid and liquid states) with reference to their formation, nature of ionic bonding and crystal structure including limitations of representations
- experimental determination of the factors affecting crystal formation of ionic compounds
- the uses of common ionic compounds.

Quantifying atoms and compounds

- the relative isotopic masses of elements and their representation on the relative mass scale using the carbon-12 isotope as the standard; reason for the selection of carbon-12 as the standard
- determination of the relative atomic mass of an element using mass spectrometry (details of instrument not required)
- the mole concept; Avogadro constant; determination of the number of moles of atoms in a sample of known mass; calculation of the molar mass of ionic compounds
- experimental determination of the empirical formula of an ionic compound.

Area of Study 2

How can the versatility of non-metals be explained?

In this area of study students explore a wide range of substances and materials made from non-metals including molecular substances, covalent lattices, carbon nanomaterials, organic compounds and polymers.

Students investigate the relationship between the electronic configurations of non-metallic atoms and the resultant structures and properties of a range of molecular substances and covalent lattices. They compare how the structures of these non-metallic substances are represented and analyse the limitations of these representations. Students study a variety of organic compounds and how they are grouped into distinct chemical families. They apply rules of systematic nomenclature to each of these chemical families. Students investigate useful materials that are made from non-metals, and relate their properties and uses to their structures. They explore the modification of polymers and the use of carbon-based nanoparticles for specific applications.

Students apply quantitative concepts to molecular compounds, including mole concept and percentage composition by mass, and determine the empirical and molecular formulas of given compounds.

Outcome 2

On completion of this unit the student should be able to investigate and explain the properties of carbon lattices and molecular substances with reference to their structures and bonding, use systematic nomenclature to name organic compounds, and explain how polymers can be designed for a purpose.

To achieve this outcome the student will draw on key knowledge outlined in Area of Study 2 and the related key skills on pages 10 and 11 of the study design.

Key knowledge

Materials from molecules

- representations of molecular substances (electron dot formulas, structural formulas, valence structures, ball-and-stick models, space-filling models) including limitations of representations
- shapes of molecules and an explanation of their polar or non-polar character with reference to the electronegativities of their atoms and electron-pair repulsion theory
- explanation of properties of molecular substances (including low melting point and boiling point, softness, and non-conduction of electricity) with reference to their structure, intramolecular bonding and intermolecular forces
- the relative strengths of bonds (covalent bonding, dispersion forces, dipole-dipole attraction and hydrogen bonding) and evidence and factors that determine bond strength including explanations for the floating of ice and expansion of water at higher temperatures.

Carbon lattices and carbon nanomaterials

- the structure and bonding of diamond and graphite that explain their properties (including heat and electrical conductivity and hardness) and their suitability for diverse applications
- the structures, properties and applications of carbon nanomaterials including graphene and fullerenes.

Organic compounds

- the origin of crude oil and its use as a source of hydrocarbon raw materials
- the grouping of hydrocarbon compounds into families (alkanes, alkenes, alkynes, alcohols, carboxylic acids and non-branched esters) based upon similarities in their physical and chemical properties including general formulas, their representations (structural formulas, condensed formulas, Lewis structures), naming according to IUPAC systematic nomenclature (limited to non-cyclic compounds up to C10, and structural isomers up to C7) and uses based upon properties
- determination of empirical and molecular formulas of organic compounds from percentage composition by mass and molar mass.

Polymers

- the formation of polymers from monomers including addition polymerisation of alkenes
- the distinction between linear (thermoplastic) and cross-linked (thermosetting) polymers with reference to structure, bonding and properties including capacity to be recycled
- the features of linear polymers designed for a particular purpose including the selection of a suitable monomer (structure and properties), chain length, degree of branching, percentage crystalline areas and addition of plasticisers
- the advantages and disadvantages of the use of polymer materials.

Area of Study 3

Research investigation

Knowledge of the origin, structure and properties of matter has built up over time through scientific and technological research, including medical research, space research and research into alternative energy resources. As a result, patterns and relationships in structures and properties of substances have been identified, applied and modified, and a vast range of useful materials and chemicals has been produced. This research and development is ongoing and new discoveries are being made at an accelerating rate.

In this area of study students apply and extend their knowledge and skills developed in Area of Study 1 and/or Area of Study 2 to investigate a selected question related to materials. They apply critical and creative thinking skills, science inquiry skills and communication skills to conduct and present the findings of an independent investigation into one aspect of the discoveries and research that have underpinned the development, use and modification of useful materials or chemicals.

Students undertake a research investigation relevant to one of the following ten options. A question from the list under each option may be selected or students may develop their own research question relevant to Area of Study 1 and/or Area of Study 2 in conjunction with their teacher. For the selected question, students outline, analyse and evaluate relevant evidence to support their conclusions.

Option 1: The origin of the elements

Questions that may be explored in this investigation include:

- How are atoms ‘seen’?
- Are there more elements to be discovered?
- What are electrons, protons and neutrons made of?
- How do we know what elements are in the Universe?
- What is the evidence that living things are made of stardust?
- Why are the ten most abundant elements in the Universe not the same as the ten most abundant elements on Earth?
- How does the abundance of elements on Earth compare with the abundance of elements in humans?
- Would there be life if elements did not form compounds?
- Why are the nuclei of some elements unstable?

Option 2: The development of the periodic table

Questions that may be explored in this investigation include:

- Is alchemy chemistry?
- How can lead be transformed into gold?
- On what basis are alternative forms of the periodic table constructed?
- Where would an element with an atomic number of 130 be placed in the modern periodic table, what properties would it have and how likely is it to be discovered?

- Why is the periodic table still a ‘work in progress’?
- Why is it difficult to place hydrogen in the modern periodic table?
- Is it worthwhile finding any more new elements?
- Why aren’t all the metals placed together in the periodic table?
- What makes some elements magnetic?
- Why do transition metals have multiple oxidation states?
- Is it an advantage or a disadvantage for elements to be unreactive?

Option 3: The lanthanoids and actinoids

Questions that may be explored in this investigation include:

- Why are some lanthanoids and actinoids so highly sought after?
- Can we live without lanthanoids and actinoids?
- Based on their usefulness for society, how would you compare the value of lanthanoids and actinoids with the value of other metal groups in the periodic table?
- Is it worth sending people to the Moon to mine for lanthanoids and actinoids?
- How are the lanthanoids and actinoids extracted from their ores?
- Do the lanthanoids and actinoids rust or corrode?
- Where are the lanthanoids and actinoids located in the periodic table and why have they been placed there?

Option 4: Using light to solve chemical puzzles

Questions that may be explored in this investigation include:

- What is a crystal, and why do crystals have regular faces?
- What makes synchrotron light useful?
- What can a synchrotron tell us about the differences between salt and sugar crystals?
- How does the composition of a crystal relate to the bonding within and the ratios of the elements present?
- Given that crystals are not alive or functioning, how is it that crystal structures are used to understand biological functions?
- What significant discoveries contributed to the development of X-ray crystallography as an analytical technique?
- How does cryoprotection preserve protein samples for analysis in a synchrotron?
- How has the use of a synchrotron enabled Nobel Prize winning research to occur?
- Why use synchrotron light to determine crystal structure when other sources of X-rays can be used?
- How does the IR beamline in the Australian Synchrotron enable the study of organic molecules and covalent bonding patterns?

Option 5: Glass

Questions that may be explored in this investigation include:

- What would life be like without glass? What might have to be used instead?
- How are the special properties achieved in particular forms of glass such as transition lenses, bullet-proof glass, safety glass, bendable glass, heat-proof glass, glass than can be switched on or off to become transparent or opaque, coloured glass and fibreglass?
- How are glass ornaments, glass jewellery and specialised laboratory glassware created?
- How does lightning make glass?
- Is glass safer to use than other forms of storage vessels?
- How useful is the type of glass that is produced as a by-product when iron is extracted from its ore in a blast furnace?

Option 6: Crude oil

Questions that may be explored in this investigation include:

- Do we need crude oil?
- Why does the composition of crude oil vary between different oil wells?
- How do different crude oil extraction methods compare with reference to ease of extraction and environmental impacts?
- What might we do if crude oil supplies run out?
- How does the time taken to produce crude oil compare with the time taken to use it?
- What fuels and other chemicals are derived from crude oil? How is crude oil processed to obtain them?
- Why are tar balls found on beaches after an oil spill?
- What are some of the issues surrounding society's demand for and use of crude oil? What strategies are being used to address some of these issues?

Option 7: Surfactants

Questions that may be explored in this investigation include:

- How do surfactants help clean up oil spills?
- Why is it so difficult to remove oil from bird feathers? Why can water birds drown if they still have detergent on their feathers?
- How are surfactants used in cooking, cosmetics and personal hygiene?
- How do hair shampoos differ from conditioners?
- How are soaps different from detergents?
- Why are different detergents made for cleaning different surfaces? How does their composition differ?
- How are surfactants designed for biodegradability?
- Does surfactant biodegradability affect performance?
- How can surfactants protect dams from drying out?
- What is the role of natural surfactants in the human body in breathing and digestion?

Option 8: Polymers and composite materials

Questions that may be explored in this investigation include:

- Are the biomaterials that replace body parts as effective as the original materials with reference to their properties and function?
- How can biomimicry help in developing new materials?
- How do new materials improve sporting performance?
- What are some of the new generation composite materials that have been designed to meet the emerging demands posed by space programs, and medical and technological developments?
- Should cars be made from shape memory metals?
- What makes some materials 'smart'?
- How do different types of radiation affect the structure and properties of polymer films?
- What applications for conductive polymers could be possible?
- What properties might a new 'super material' have, what might it be made from and what difference could it make to people's lives?
- Why would it be an advantage for polymers not to be biodegradable?
- How are new polymer and composite materials tested for safety?

Option 9: Nanomaterials

Questions that may be explored in this investigation include:

- What useful materials have resulted from nanomaterial research and what could be produced in future?
- How are nanochemists able to 'see' nanoparticles and manipulate atoms to build particular nanomaterials?
- Why do nanomaterials have different properties to their related macromaterials?
- Are nanomaterials safe?
- What difference can nanomaterials make to society and the environment?
- What can nanobots do?
- How are nanomaterials used in medicine and research?

Option 10: The life cycle of a selected material or chemical

Questions that may be explored in this investigation include:

- What is the story behind the discovery of a selected material or chemical and why is it important?
- What is the relationship between the properties, structure and the nature and strength of the chemical bonding within the structure of a selected material or chemical?
- What are the main features of the life cycle of a selected material or chemical and how can these features be represented (they may include the extraction and processing of the raw materials; the manufacturing processes used, its packaging, distribution and use; any recycling and reuse; and its disposal at the end of its useful life)?
- What health and safety and environmental issues are involved in the manufacture, use and disposal of a selected material or chemical and how are these managed?
- What happens to a selected material or chemical at the end of its life?

Outcome 3

On completion of this unit the student should be able to investigate a question related to the development, use and/or modification of a selected material or chemical and communicate a substantiated response to the question.

To achieve this outcome the student will draw on key knowledge outlined in Area of Study 3 and the related key skills on pages 10 and 11 of the study design.

Key knowledge

- the characteristics of effective science communication: accuracy of chemical information; clarity of explanation of chemical concepts, ideas and models; contextual clarity with reference to importance and implications of findings; conciseness and coherence
- the chemical concepts specific to the investigation: definitions of key terms; use of appropriate chemical terminology, conventions, units and representations
- the use of data representations, models and theories in organising and explaining observed phenomena and chemical concepts, and their limitations
- the nature of evidence and information: distinction between weak and strong evidence, and scientific and non-scientific ideas; and validity, reliability and authority of data including sources of possible errors or bias
- the influence of social, economic, environmental and ethical factors relevant to the selected chemical investigation.

Assessment

The award of satisfactory completion for a unit is based on a decision that the student has demonstrated the set of outcomes specified for the unit. Teachers should use a variety of learning activities and assessment tasks that provide a range of opportunities for students to demonstrate the key knowledge and key skills in the outcomes.

The areas of study, including the key knowledge and key skills listed for the outcomes should be used for course design and the development of learning activities and assessment tasks. Assessment must be a part of the regular teaching and learning program and should be completed mainly in class and within a limited timeframe.

All assessment at Units 1 and 2 are school-based. Procedures for assessment of levels of achievement in Units 1 and 2 are a matter for school decision.

For this unit students are required to demonstrate achievement of three outcomes. As a set these outcomes encompass all areas of study.

Suitable tasks for assessment may be selected from the following:

For Outcomes 1 and 2

- annotations of a practical work folio of activities or investigations
- a report of a practical activity or investigation
- a modelling activity
- media response
- problem-solving involving chemical concepts, skills and/or issues
- a reflective learning journal/blog related to selected activities or in response to an issue
- data analysis
- a test comprising multiple choice and/or short answer and/or extended response.

For Outcome 3

- a report of an independent investigation of a topic selected from Area of Study 1 and/or Area of Study 2, using an appropriate format, for example digital presentation, oral communication or written report.

Where teachers allow students to choose between tasks they must ensure that the tasks they set are of comparable scope and demand.

Practical work is a central component of learning and assessment. As a guide, between 3½ and 5 hours of class time should be devoted to student practical work and investigations for each of Areas of Study 1 and 2. For Area of Study 3, between 4 and 6 hours of class time should be devoted to undertaking the investigation and communicating findings.

Unit 2: What makes water such a unique chemical?

Water is the most widely used solvent on Earth. In this unit students explore the physical and chemical properties of water, the reactions that occur in water and various methods of water analysis.

Students examine the polar nature of a water molecule and the intermolecular forces between water molecules. They explore the relationship between these bonding forces and the physical and chemical properties of water. In this context students investigate solubility, concentration, pH and reactions in water including precipitation, acid-base and redox. Students are introduced to stoichiometry and to analytical techniques and instrumental procedures, and apply these to determine concentrations of different species in water samples, including chemical contaminants. They use chemistry terminology including symbols, units, formulas and equations to represent and explain observations and data from experiments, and to discuss chemical phenomena. Students explore the solvent properties of water in a variety of contexts and analyse selected issues associated with substances dissolved in water.

A practical investigation into an aspect of water quality is undertaken in Area of Study 3. The investigation draws on content from Area of Study 1 and/or Area of Study 2.

Area of Study 1

How do substances interact with water?

In this area of study students focus on the properties of water and the reactions that take place in water including acid-base and redox reactions. Students relate the properties of water to the water molecule's structure, polarity and bonding. They also explore the significance of water's high specific heat capacity and latent heat of vaporisation for living systems and water supplies.

Students investigate issues associated with the solubility of substances in water. Precipitation, acid-base and redox reactions that occur in water are explored and represented by the writing of balanced equations. Students compare acids with bases and learn to distinguish between acid strength and acid concentration. The pH scale is examined and students calculate the expected pH of strong acids and strong bases of known concentration.

Outcome 1

On completion of this unit the student should be able to relate the properties of water to its structure and bonding, and explain the importance of the properties and reactions of water in selected contexts.

To achieve this outcome the student will draw on key knowledge outlined in Area of Study 1 and the related key skills on pages 10 and 11 of the study design.

Key knowledge

Properties of water

- trends in the melting and boiling points of Group 16 hydrides, with reference to the nature and relative strengths of their intermolecular forces and to account for the exceptional values for water
- specific heat capacity and latent heat including units and symbols, with reference to hydrogen bonding to account for the relatively high specific heat capacity of liquid water, and significance for organisms and water supplies of the relatively high latent heat of vaporisation of water.

Water as a solvent

- the comparison of solution processes in water for molecular substances and ionic compounds
- precipitation reactions represented by balanced full and ionic equations, including states
- the importance of the solvent properties of water in selected biological, domestic or industrial contexts.

Acid-base (proton transfer) reactions in water

- the Brønsted-Lowry theory of acids and bases including polyprotic acids and amphiprotic species, and writing of balanced ionic equations for their reactions with water including states
- the ionic product of water, the pH scale and the use of pH in the measurement and calculations of strengths of acids and bases and dilutions of solutions (calculations involving acidity constants are not required)
- the distinction between strong and weak acids and bases, and between concentrated and dilute acids and bases, including common examples
- the reactions of acids with metals, carbonates and hydroxides including balanced full and ionic equations, with states indicated
- the causes and effects of a selected issue related to acid-base chemistry.

Redox (electron transfer) reactions in water

- oxidising and reducing agents, conjugate redox pairs and redox reactions including writing of balanced half and overall redox equations with states indicated
- the reactivity series of metals and metal displacement reactions including balanced redox equations with states indicated
- the causes and effects of a selected issue related to redox chemistry.

Area of Study 2

How are substances in water measured and analysed?

In this area of study students focus on the use of analytical techniques, both in the laboratory and in the field, to measure the solubility and concentrations of solutes in water, and to analyse water samples for various solutes including chemical contaminants.

Students examine the origin and chemical nature of substances that may be present in a water supply, including contaminants, and outline sampling techniques used to assess water quality. They measure the solubility of substances in water, explore the relationship between solubility and temperature using solubility curves and learn to predict when a solute will dissolve or crystallise out of solution.

The concept of molarity is introduced and students measure concentrations of solutions using a variety of commonly used units. Students apply the principles of stoichiometry to gravimetric and volumetric analyses of aqueous solutions and water samples. Instrumental techniques include the use of colorimetry and/or UV-visible spectroscopy to estimate the concentrations of coloured species in solution, atomic absorption spectroscopy data to determine the concentration of metal ions in solution and high performance liquid chromatography data to calculate the concentration of organic compounds in solution.

Outcome 2

On completion of this unit the student should be able to measure amounts of dissolved substances in water and analyse water samples for salts, organic compounds and acids and bases.

To achieve this outcome the student will draw on key knowledge outlined in Area of Study 2 and the related key skills on pages 10 and 11 of the study design.

Key knowledge

Water sample analysis

- existence of water in all three states at Earth's surface including the distribution and proportion of available drinking water
- sampling protocols including equipment and sterile techniques for the analysis of water quality at various depths and locations
- the definition of a chemical contaminant and an example relevant to a selected water supply.

Measurement of solubility and concentration

- the use of solubility tables and experimental measurement of solubility in gram per 100 g of water
- the quantitative relationship between temperature and solubility of a given solid, liquid or gas in water
- the use of solubility curves as a quantitative and predictive tool in selected biological, domestic or industrial contexts
- the concept of solution concentration measured with reference to moles (mol L^{-1}) or with reference to mass or volume (g L^{-1}, mg L^{-1}, %(m/m), %(m/v), %(v/v), ppm, ppb) in selected domestic, environmental, commercial or industrial applications, including unit conversions.

Analysis for salts in water

- sources of salts found in water (may include minerals, heavy metals, organo-metallic substances) and the use of electrical conductivity to determine the salinity of water samples
- the application of mass-mass stoichiometry to gravimetric analysis to determine the mass of a salt in a water sample
- the application of colorimetry and/or UV-visible spectroscopy, including the use of a calibration curve, to determine the concentration of coloured species (ions or complexes) in a water sample
- the application of atomic absorption spectroscopy (AAS), including the use a calibration curve, to determine the concentration of metals or metal ions in a water sample (excluding details of instrument).

Analysis for organic compounds in water

- sources of organic contaminants found in water (may include dioxins, insecticides, pesticides, oil spills)
- the application of high performance liquid chromatography (HPLC) including the use of a calibration curve and retention time to determine the concentration of a soluble organic compound in a water sample (excluding details of instrument).

Analysis for acids and bases in water

- sources of acids and bases found in water (may include dissolved carbon dioxide, mining activity and industrial wastes)
- volume-volume stoichiometry (solutions only) and application of volumetric analysis including the use of indicators, calculations related to preparation of standard solutions, dilution of solutions and use of acid-base titrations to determine the concentration of an acid or a base in a water sample.

Area of Study 3

Practical investigation

Substances that are dissolved in water supplies may be beneficial or harmful, and sometimes toxic, to humans and other living organisms. They may also form coatings on, or corrode, water pipes. In this area of study students design and conduct a practical investigation into an aspect of water quality. The investigation relates to knowledge and skills developed in Area of Study 1 and/or Area of Study 2 and is conducted by the student through laboratory work and/or fieldwork.

The investigation requires the student to develop a question, plan a course of action that attempts to answer the question, undertake an investigation to collect the appropriate primary qualitative and/or quantitative data (which may including collecting water samples), organise and interpret the data and reach a conclusion in response to the question.

Outcome 3

On completion of this unit the student should be able to design and undertake a quantitative laboratory investigation related to water quality, and draw conclusions based on evidence from collected data.

To achieve this outcome the student will draw on key knowledge outlined in Area of Study 3 and the related key science skills on pages 10 and 11 of the study design.

Key knowledge

- the chemical concepts specific to the investigation and their significance, including definitions of key terms, and chemical representations
- the characteristics of laboratory techniques of primary qualitative and quantitative data collection relevant to the investigation: sampling protocols; gravimetric analysis, acid-base titrations and/or pH measurement; precision, accuracy, reliability and validity of data; and minimisation of experimental bias
- ethics of and concerns with research including identification and application of relevant health and safety guidelines
- methods of organising, analysing and evaluating primary data to identify patterns and relationships including identification of sources of error and uncertainty, and of limitations of data and methodologies
- observations and experiments that are consistent with, or challenge, current chemical models or theories
- the nature of evidence that supports or refutes a hypothesis, model or theory
- options, strategies or solutions to issues related to water quality
- the key findings of the selected investigation and their relationship to solubility, concentration, acid/base and/or redox concepts
- the conventions of scientific report writing including chemical terminology and representations, symbols, chemical equations, formulas, units of measurement, significant figures and standard abbreviations.

Assessment

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The areas of study, including the key knowledge and key skills listed for the outcomes, should be used for course design and the development of learning activities and assessment tasks. Assessment must be a part of the regular teaching and learning program and should be completed mainly in class and within a limited timeframe.

All assessment at Units 1 and 2 are school-based. Procedures for assessment of levels of achievement in Units 1 and 2 are a matter for school decision.

For this unit students are required to demonstrate achievement of three outcomes. As a set these outcomes encompass all areas of study.

Suitable tasks for assessment may be selected from the following:

For Outcomes 1 and 2

- annotations of a practical work folio of activities or investigations
- a report of a practical activity or investigation
- a modelling activity
- media response
- problem solving involving chemical concepts, skills and/or issues
- a reflective learning journal/blog related to selected activities or in response to an issue
- data analysis
- a test comprising multiple choice and/or short answer and/or extended response.

For Outcome 3

- a report of a student-designed quantitative laboratory investigation using an appropriate format, for example digital presentation, oral communication, scientific poster or written report.

Where teachers allow students to choose between tasks they must ensure that the tasks they set are of comparable scope and demand.

Practical work is a central component of learning and assessment. As a guide, between 3½ and 5 hours of class time should be devoted to student practical work and investigations for each of Areas of Study 1 and 2. For Area of Study 3, between 4 and 6 hours of class time should be devoted to undertaking the investigation and communicating findings.