



Government of **Western Australia**
School Curriculum and Standards Authority

CHEMISTRY

GENERAL COURSE

Year 12 syllabus

IMPORTANT INFORMATION

This syllabus is effective from 1 January 2017.

Users of this syllabus are responsible for checking its currency.

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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. This Chemistry General course will develop 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, as 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 the Chemistry General course will provide 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, 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 General 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 12 syllabus is divided into two units which are delivered as a pair. The notional time for the pair of units is 110 class contact hours.

Unit 3

In this unit, students further investigate the role that chemistry plays in their daily lives. They begin by investigating the naturally occurring, smelly, yellow-to-black liquid consisting of a complex mixture of hydrocarbons of various molecular weights, and other liquid organic compounds, that is crude oil. They examine its composition and the chemistry of some of the compounds that comprise it. This leads to an investigation of other oils, their sources, properties and uses, and finally, they consider the constituents, properties and uses of polymers.

Students appreciate the role of chemistry in contributing to a sustainable future by investigating recycling and disposal of community chemical wastes. They investigate ways that chemists assist in protecting the natural environment, such as by producing biodegradable alternatives, and by conservation and management of our resources. They recognise and acknowledge that the use of scientific knowledge may have beneficial and/or harmful and/or unintended consequences.

Unit 4

In this unit, students investigate the chemistry of one of two different fields: one, the chemistry of metals, will introduce them to the physical and chemical properties of a crucially important group of materials. They will test the properties of metals and relate these to their means of extraction, purification and uses. Finally, students will consider the properties of alloys and the deleterious effects of corrosion.

The second field is the chemistry associated with living processes. In this biochemical field, students will investigate the structure and function of two groups of chemicals, proteins and carbohydrates and one particular molecule, adenosine triphosphate (ATP). The roles in the body of carbohydrates, and ATP will be examined, including their roles in exercise. The factors that affect the catalytic function of the particular group of proteins, enzymes, will be studied and related to changing conditions of their environment, the body.

Each unit includes:

- a unit description – a short description of the focus of the unit
- suggested contexts – a context in which the unit content could be taught
- unit content – the content to be taught and learned.

Organisation of content

Science strand descriptions

The Science curriculum has three interrelated strands: Science Inquiry Skills, Science as a Human Endeavour and Science Understanding. These strands are used to organise the Science learning area from Foundation to Year 12. In the senior secondary science courses, the three strands build on students' learning in the Year 7–10 Science curriculum.

In the practice of science, the three strands are closely integrated: the work of scientists reflects the nature and development of science, is built around scientific inquiry, and seeks to respond to and influence society. Students' experiences of school science should mirror this multifaceted view of science. To achieve this, the three strands of the Science curriculum 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. The investigation design will depend on the context and subject of the investigation.

Science as a Human Endeavour

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.

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 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.

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.

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 or territory health and safety guidelines.

Animal ethics

Through a consideration of research ethics as part of Science Inquiry Skills, students will examine their own ethical position, draw on ethical perspectives when designing investigation methods, and ensure that any activities that impact on living organisms comply with the *Australian code of practice for the care and use of animals for scientific purposes 8th edition 2013* (www.nhmrc.gov.au/guidelines/publications/ea28).

Any teaching activities that involve the care and use of, or interaction with, animals must comply with the *Australian code of practice for the care and use of animals for scientific purposes 8th edition 2013*, in addition to relevant state or territory guidelines.

Information regarding the care and use of animals in Western Australian schools and agricultural colleges can be viewed at www.det.wa.edu.au/curriculumsupport/animalethics/detcms/portal/.

Mathematical skills expected of students studying the Chemistry General course

The Chemistry curriculum requires students to use the mathematical skills they have developed through the P–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 competently:

- perform calculations involving addition, subtraction, multiplication and division of quantities
- express fractions as percentages, and percentages as fractions
- calculate percentages
- recognise and use ratios
- convert between simple SI units, for example, milligrams to grams, grams to kilogram and millilitres to litres
- change the subject of a simple equation
- substitute physical quantities into an equation using consistent units
- comprehend and use the symbols/notations $<$, $>$, Δ , \approx

- translate information between graphical and numerical forms
- use appropriate forms, variables and scales for constructing graphs and tables.
- interpret frequency tables and diagrams, pie charts and histograms
- describe and compare data sets using mean
- interpret the shape of a graph.

Representation of the general capabilities

The general capabilities encompass the knowledge, skills, behaviours and dispositions that will assist students to live and work successfully in the twenty-first century. Teachers may find opportunities to incorporate the capabilities into the teaching and learning program for the Chemistry General course. The general capabilities are not assessed unless they are identified within the specified unit content.

Literacy

Literacy is important in students' development of Science Inquiry Skills and their understanding of content presented through the Science Understanding and Science as a Human Endeavour strands. Students gather, interpret, synthesise and critically analyse information presented in a wide range of genres, modes and representations (including text, flow diagrams, symbols, graphs and tables). They evaluate information sources and compare and contrast ideas, information and opinions presented within and between texts. They communicate processes and ideas logically and fluently and structure evidence-based arguments, selecting genres and employing appropriate structures and features to communicate for specific purposes and audiences.

Numeracy

Numeracy is key to students' ability to apply a wide range of Science Inquiry Skills, including making and recording observations; ordering, representing and analysing data; and interpreting trends and relationships. They employ numeracy skills to interpret complex spatial and graphic representations, and to appreciate the ways in which chemical systems are structured, interact and change across spatial and temporal scales. They engage in analysis of data, including issues relating to reliability and probability, and they interpret and manipulate mathematical relationships to calculate and predict values.

Information and communication technology capability

Information and communication technology (ICT) capability is a key part of Science Inquiry Skills. Students use a range of strategies to locate, access and evaluate information from multiple digital sources; to collect, analyse and represent data; to model and interpret concepts and relationships; and to communicate and share science ideas, processes and information. Through exploration of Science as a Human Endeavour concepts, students assess the impact of ICT on the development of science and the application of science in society, particularly with regard to collating, storing, managing and analysing large data sets.

Critical and creative thinking

Critical and creative thinking is particularly important in the science inquiry process. Science inquiry requires the ability to construct, review and revise questions and hypotheses about increasingly complex and abstract scenarios and to design related investigation methods. Students interpret and evaluate data; interrogate, select and cross-reference evidence; and analyse processes, interpretations, conclusions and claims for validity and reliability, including reflecting on their own processes and conclusions. Science is a creative endeavour and students devise innovative solutions to problems, predict possibilities, envisage consequences and speculate on possible outcomes as they develop Science Understanding and Science Inquiry Skills. They also appreciate the role of critical and creative individuals and the central importance of critique and review in the development and innovative application of science.

Personal and social capability

Personal and social capability is integral to a wide range of activities in the Chemistry General course, as students develop and practise skills of communication, teamwork, decision-making, initiative-taking and self-discipline with increasing confidence and sophistication. In particular, students develop skills in both independent and collaborative investigation; they employ self-management skills to plan effectively, follow procedures efficiently and work safely; and they use collaboration skills to conduct investigations, share research and discuss ideas. In considering aspects of Science as a Human Endeavour, students also recognise the role of their own beliefs and attitudes in their response to science issues and applications, consider the perspectives of others, and gauge how science can affect people's lives.

Ethical understanding

Ethical understanding is a vital part of science inquiry. Students evaluate the ethics of experimental science, codes of practice, and the use of scientific information and science applications. They explore what integrity means in science, and they understand, critically analyse and apply ethical guidelines in their investigations. They consider the implications of their investigations on others, the environment and living organisms. They use scientific information to evaluate the claims and actions of others and to inform ethical decisions about a range of social, environmental and personal issues and applications of science.

Intercultural understanding

Intercultural understanding is fundamental to understanding aspects of Science as a Human Endeavour, as students appreciate the contributions of diverse cultures to developing science understanding and the challenges of working in culturally diverse collaborations. They develop awareness that raising some debates within culturally diverse groups requires cultural sensitivity, and they demonstrate open-mindedness to the positions of others. Students also develop an understanding that cultural factors affect the ways in which science influences and is influenced by society.

Representation of the cross-curriculum priorities

The cross-curriculum priorities address the contemporary issues which students face in a globalised world. Teachers may find opportunities to incorporate the priorities into the teaching and learning program for the Chemistry General course. The cross-curriculum priorities are not assessed unless they are identified within the specified unit content.

Aboriginal and Torres Strait Islander histories and cultures

Through an investigation of contexts that draw on Aboriginal and Torres Strait Islander histories and cultures, students can appreciate the role of Aboriginal and Torres Strait Islander Peoples' knowledge in developing richer understandings of the chemical diversity in the Australian environment, for example, the chemical properties of plants used for bush medicines, or mineral ores used for decoration or artwork, and how items in the natural environment were used before modern materials became available.

Asia and Australia's engagement with Asia

Contexts that draw on Asian scientific research and development and collaborative endeavours in the Asia Pacific region provide an opportunity for students to investigate Asia and Australia's engagement with Asia. Students can examine the important role played by people of the Asia region in such areas as medicine, materials science, nanotechnology, energy security and food security. They can consider collaborative projects between Australian and Asian scientists and the contribution these make to scientific knowledge.

Sustainability

In the Chemistry General course, the Sustainability cross-curriculum priority provides authentic contexts for exploring, investigating and understanding the function and interactions of chemical systems. Chemistry explores a wide range of chemical systems that operate at different time and spatial scales. By investigating the relationships between chemical systems and system components, and how systems respond to change, students develop an appreciation for the ways in which interactions between matter and energy connect Earth's biosphere, geosphere, hydrosphere and atmosphere. Students appreciate that chemical science and its applications provide the basis for decision making in many areas of society and that these decisions can impact on the Earth system. They understand the importance of using science to predict possible effects of human and other activity, such as ocean acidification, mineral extraction or use of fossil fuels, and to develop management plans, alternative technologies or approaches, such as green chemistry, that minimise these effects and provide for a more sustainable future.

Unit 3

Unit description

In this unit, students further investigate the role that chemistry plays in their daily lives. They begin by investigating the naturally occurring, smelly, yellow-to-black liquid consisting of a complex mixture of hydrocarbons of various molecular weights, and other liquid organic compounds, that is crude oil. They examine its composition and the chemistry of some of the compounds that comprise it. This leads to an investigation of other oils, their sources, properties and uses, and finally, they consider the constituents, properties and uses of polymers.

Students appreciate the role of chemistry in contributing to a sustainable future by investigating recycling and disposal of community chemical wastes. They investigate ways that chemists assist in protecting the natural environment, such as by producing biodegradable alternatives, and by conservation and management of our resources. They recognise and acknowledge that the use of scientific knowledge may have beneficial and/or harmful and/or unintended consequences.

Suggested contexts

The suggested context for the teaching of concepts within Unit 3 is carbon chemistry.

Unit content

It is recommended that students studying Unit 3 have completed a review of the following Unit 1 content:

- the language of chemistry
- the differences between elements, compounds and mixtures.

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

Science Inquiry Skills

- construct questions for investigation; propose hypotheses; and predict possible outcomes
- plan investigations, including the procedure(s) to be followed, the materials required, and the type and amount of data to be collected; assess risk and address ethical issues associated with these methods
- conduct investigations, appropriate to the chosen context(s), safely, competently and methodically for the collection of reliable data, including the chemical identification of saturated and unsaturated compounds and the production and testing of a simple polymer, for example, casein glue or slime or similar
- represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error and inconsistencies in data; and use evidence to make and justify conclusions
- interpret a range of scientific and media texts, and evaluate the conclusions by considering the quality of available evidence
- construct and use appropriate representations, to communicate conceptual understanding, solve problems and make predictions

- communicate scientific ideas and information for a specific purpose using appropriate language, nomenclature and formats, including scientific reports

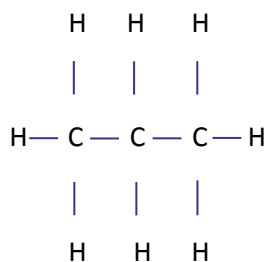
Science as a Human Endeavour

- most hydrocarbon fuels produced from crude oil also contain sulfur. When a fuel burns in air, gases, such as carbon dioxide, sulfur dioxide and oxides of nitrogen, are released into the atmosphere. Solid particles may also be released. The burning of hydrocarbon fuels contributes to acid rain, global warming and global dimming. Technology has been developed to chemically remove sulfur dioxide from waste gases after combustion in power plants and international cooperation has resulted in industrialised countries reducing emissions of greenhouse gases, such as carbon dioxide
- biofuels, such as biodiesel and ethanol, are produced from plant material. The production of biofuels is sustainable and biofuels produce fewer pollutants than hydrocarbon fuels made from crude oil. There are economic, ethical and environmental issues surrounding the use of biofuels, for example, using cropland to grow crops for fuel rather than for food may have an impact on the cost of food or lead to food shortages
- many polymers are not biodegradable. Non-biodegradability can lead to problems with waste disposal and recycling. Some products, such as plastic bags, packaging and disposable cutlery, are being made from a combination of polymers and other additives, such as starch, so that they break down more easily. The use of these products may provide benefits, such as reduced green-house gas emissions and reduced use of crude oil substances. The benefits need to be offset against any increased costs in production

Science Understanding

Crude oil

- crude oil is a mixture of a very large number of compounds
- the substances in crude oil can be separated using fractional distillation
- crude oil is made up of hydrocarbons; hydrocarbons consist of only hydrogen and carbon atoms
- most of the hydrocarbons found in crude oil are called alkanes; alkanes are hydrocarbons that contain only single carbon to carbon bonds and are described as saturated
- alkanes can be named using IUPAC conventions (C_1 – C_8 , straight chain only)
- alkanes can be represented using structural formula (C_1 – C_8 , straight chain only) for example, propane (C_3H_8)

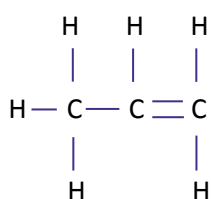


Please note: for teaching purposes, in structural formulae ' — ' should be described as a chemical bond.

- some properties of hydrocarbons, for example, boiling point and viscosity, depend on the number of atoms in the hydrocarbon; these properties influence how hydrocarbons are used as fuels and lubricants

Other substances from crude oil

- substances separated from the fractional distillation of crude oil can be broken down (cracked) to make smaller hydrocarbons, such as alkenes
- alkenes are hydrocarbons that contain at least one carbon to carbon double bond and are described as unsaturated
- alkenes can be named using IUPAC conventions (C₂-C₃ only)
- alkenes can be represented using structural formulae (one double bond), for example, propene (C₃H₆)



Polymers

- alkenes can be used to make very large molecules called polymers, for example, polyethene and polypropene and polystyrene
- many small molecules, called monomers, are joined together to form polymers
- polymers have many useful applications, for example, plastics, water saving hydrogels, encapsulated microbes, and waterproof coatings for fabrics
- information on plastic packaging identifies the type of plastic and recycling process used

Vegetable oils

- some fruits, seeds and nuts are rich in oils that can be extracted
- vegetable oils are important foods and fuels as they provide a lot of energy
- oils are insoluble in water; oils can be used to produce emulsions, for example, in food and cosmetics
- vegetable oils that are unsaturated contain double carbon to carbon chemical bonds; these can be distinguished using bromine water or a dilute solution of iodine in ethanol

Biofuels

- vegetable oils can be used to make biofuels
- ethanol is an alcohol with the formula CH₃CH₂OH
- ethanol can be used as a biofuel
- ethanol can be produced by fermentation

Unit 4

Unit description

In this unit, students investigate the chemistry of one of two different fields. The first is the field of the chemistry of metals. This will introduce them to the physical and chemical properties of a crucially important group of materials. They will test the properties of metals and relate these to their means of extraction, purification and uses. Finally, students will consider the properties of alloys and the deleterious effects of corrosion.

The second field is the chemistry associated with living processes. In this biochemical field, students will investigate the structure and function of two groups of chemicals, proteins and carbohydrates, and one particular molecule, adenosine triphosphate (ATP). The roles of carbohydrates and ATP in the human body will be examined, including their roles in exercise. The factors that affect the catalytic function of the particular group of proteins, enzymes, will be studied and related to changing conditions of their environment, the body.

Suggested contexts

Teachers must choose one of the following contexts when teaching Unit 4.

- materials chemistry
- biochemistry

Unit content

It is recommended that students studying Unit 4 have completed a review of the following Unit 1 content:

- the language of chemistry
- the differences between atoms, molecules and ions
- the differences between elements, compounds and mixtures
- chemical reactions and rates.

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

Science Inquiry Skills

- construct questions for investigation; propose hypotheses; and predict possible outcomes
- plan investigations, including the procedure(s) to be followed, the materials required, and the type and amount of data to be collected; assess risk and address ethical issues associated with these methods
- conduct investigations, appropriate to the chosen context(s), safely, competently and methodically for the collection of reliable data
- represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error and inconsistencies in data; and use evidence to make and justify conclusions

- interpret a range of scientific and media texts, and evaluate the conclusions by considering the quality of available evidence
- construct and use appropriate representations, to communicate conceptual understanding, solve problems and make predictions
- communicate scientific ideas and information for a specific purpose using appropriate language, nomenclature and formats, including scientific reports

Science as a Human Endeavour

Materials chemistry

- Aboriginal Peoples mined a variety of ochres, which contained mixtures of hydrated oxides of iron. The ochre and water was mixed into a paste and then formed into blocks for ease of transport. The pigments were made by grinding the ochre to a powder and mixing it with a fluid, for example, saliva. Aboriginal Peoples used the pigments from the ochre to paint their bodies, implements and caves. Ochre was extensively traded; red ochre was particularly valuable as it symbolises the blood of ancestral beings
- shape memory alloys (SMAs) are metals that can return to their original shape after being deformed. This allows them to be used as actuators in many applications, such as in fire sprinkler systems, anti-scalding valves in showers and guide wires in dental braces
- the extraction of metals from ores involves the use of limited resources and is expensive in terms of energy and effects on the environment. New ways of extracting copper from low grade ores, for example bioleaching and phytomining, are being researched to limit the environmental impact of traditional mining methods
- almost all engineering materials, for example steel, are subject to corrosion. Corrosion can result in train derailments, collapsed bridges and power outages. Due to the economic costs involved, corrosion research groups collaborate to develop new treatment methods and structural design features to reduce the amount of corrosion

Biochemistry

- a knowledge of the chemical reactions that occur in the human body is used in the field of pathology. Body fluid samples, for example, blood and urine, can be analysed for a range of chemical substances using a variety of analytical techniques. If the concentration of the chemical substance being analysed is not within the normal range, it may indicate that a particular organ, for example the liver or kidney, is not functioning correctly, or that disease is present
- in people with diabetes, insulin (a protein hormone) is no longer produced or not produced in sufficient amounts by the pancreas. Insulin helps convert glucose in the blood into glycogen for storage in the liver and muscles. Diabetics regularly monitor their blood glucose levels to ensure that they are not too high. Blood glucose monitoring involves diabetics pricking their finger to obtain a blood sample. Inconvenience, sore fingers, and a fear of needles may cause diabetics to not regularly monitor glucose levels. Emerging technologies, for example, smart phone apps, help calculate insulin dosage. Non-invasive products, such as ring-shaped probes which are placed on the outside of the finger, help diabetics to monitor their glucose levels

- sports drinks and diet supplements are formulated using a knowledge of biochemistry. The composition and form of sports drinks and diet supplements is changed by manufacturers in response to new scientific information becoming available, as well as in response to social, economic and ethical considerations
- performance enhancing drugs, for example, a protein hormone, erythropoietin (EPO), can increase oxygen delivery to the muscles, improving their endurance capacity. The use of banned performance enhancing drugs in sports provides an unfair advantage. Their use can result in health complications, for example, stroke. The decision by athletes to take performance enhancing drugs may be influenced by social, economic, ethical and political considerations

Science Understanding

Materials chemistry

Metal properties and structure

- metals can be distinguished from non-metals by their physical and chemical properties
- metals and non-metals can be identified by their position on the periodic table
- metals consist of giant structures of atoms arranged in a regular pattern
- the layers of atoms in metals are able to slide over each other, so metals can be bent and shaped
- metals have a range of melting points and relatively high boiling points
- different metals have different abilities to conduct heat and electricity
- conductivity depends on the ability of electrons to move throughout the metal
- electrical conductivity can be measured using a simple circuit or one which could include an ammeter or a multimeter
- the properties of metals determine how they are used, for example, copper is useful for electrical wiring and plumbing
- flame tests can be used to identify metals
- transition metals form coloured compounds; this enables them to be used for many purposes, for example, paint pigments, coloured glass and ceramics

Alloys

- metals can form mixtures with other metals and substances like carbon to make alloys, for example, stainless steel
- alloys have different physical properties when compared to pure metals; this can increase the range of purposes that an alloy is suitable for

Metal reactions

- observations, word equations and simple chemical equations for the following chemical reaction types:
 - acid-metal
 - metal carbonate decomposition
 - simple metal displacement
- metal/metal ion displacement reactions can be used to investigate differences in metal reactivity

Metal extraction

- unreactive metals, for example gold, are found in the Earth as the metal itself, but most metals are found as compounds
- copper can be extracted from ores
- the percentage of metal in an ore can be calculated from the mass of the metal in the ore and the mass of the ore sample
- copper can be obtained from solution by electrolysis, or by displacement using iron

Metal corrosion

- corrosion is the gradual break down of materials by chemical reaction with the environment
- corrosion occurs when metals react with oxygen to form metal oxides, for example, aluminium and iron
- when aluminium reacts with oxygen, the resulting aluminium oxide forms a tough coating that protects the metal underneath from further contact with oxygen
- when iron reacts with oxygen and water, it forms a corrosion product called rust. Rust on the surface of the iron is porous, allowing the metal underneath to come into further contact with oxygen and water
- the rate of corrosion of iron can be influenced by a number of factors, for example, moisture and impurities
- the rate of corrosion of iron can be slowed down when it is alloyed with other metals, in contact with a more reactive metal, or when it has a protective coating

Biochemistry**Proteins**

- proteins are large molecules (polymers) made up from smaller molecules (monomers) called amino acids
- amino acids consist mainly of carbon, hydrogen and nitrogen atoms and sometimes sulfur atoms
- there are many different types of proteins that carry out different functions, for example:
 - structural proteins (protection, support, movement), for example, hair and muscle
 - enzymes (biological catalysts), for example, amylase, catalase and pepsin
 - hormones (regulation of body functions), for example, insulin
 - transport (movement of molecules in body), for example, haemoglobin
 - the catalytic activity of enzymes is dependent on temperature and pH

Carbohydrates

- carbohydrates consist of carbon, hydrogen and oxygen atoms
- carbohydrates are stored as glycogen in the muscles and liver
- glycogen is a large molecule (polymer) made up from smaller molecules (monomers) of glucose
- glucose is the main source of energy in the diet, in preference to fats and proteins

During exercise

- glycogen is broken down to form glucose
- cellular respiration is a chemical reaction that takes place in the cells of the body to produce energy. Cells use adenosine triphosphate (ATP) from glucose and oxygen to supply their energy needs
- cellular respiration requires oxygen to generate ATP and is also called 'aerobic respiration'
- cellular respiration can be represented using a simple word equation
- muscles are made up of multiple bundles of muscle fibres (cells) held together by connective tissue
- skeletal muscle fibres can be classified into two broad categories, Type I and Type II
- Type I muscle fibres appear red due to the presence of a protein (myoglobin) which binds oxygen; Type II muscle fibres appear white as they lack this protein
- ATP is used up when muscles move and contract
- endurance exercise uses mainly Type I muscle fibres and involves aerobic respiration
- exercise that involves short bursts of speed and power, for example sprinting, uses mainly Type II muscle fibres and involves anaerobic respiration
- anaerobic respiration produces ATP from the breakdown of glucose without the presence of oxygen
- lactic acid is produced by anaerobic respiration and accumulates in muscle cells. This causes a decrease in the pH of the muscle cells, leading to an impairment of muscle contractions
- ions (electrolytes) must be present in appropriate concentrations to maintain muscle contraction and fluid balance
- sweating causes loss of water which can lead to dehydration and the excretion of ions (electrolytes) for example, sodium, potassium, magnesium and chloride ions

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 General Year 12 syllabus and the weighting for each assessment type.

Assessment table – Year 12

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 scientific reports. The assessed component of tasks of these types should be conducted in a supervised classroom setting.	40%
Extended response Tasks requiring an extended response may involve selecting and 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 may 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.	20%
Test Tests typically consist of multiple choice questions, and questions requiring short and extended answers. This assessment type is conducted in supervised classroom settings.	25%
Externally set task A written task or item or set of items of 50 minutes duration developed by the School Curriculum and Standards Authority and administered by the school.	15%

Teachers are required to use the assessment table to develop an assessment outline for the pair of units.

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).

All assessment types must be included in the assessment outline at least twice with the exception of the externally set task which only occurs once.

The set of assessment tasks must provide a representative sampling of the content for Unit 3 and Unit 4.

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

Externally set task

All students enrolled in the Chemistry General Year 12 course will complete the externally set task developed by the Authority. Schools are required to administer this task in Term 2 at a time prescribed by the Authority.

Externally set task design brief – Year 12

Time	50 minutes
Format	Written
	Conducted under invigilated conditions
	Typically between two and six questions
Content	The Authority informs schools during Term 3 of the previous year of the Unit 3 syllabus content on which the task will be based

Refer to the WACE Manual for further information.

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. 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 General Year 12 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 12

A

Understanding and applying concepts

Applies chemical models and principles to explain properties, structures and behaviours of substances, in detail.

Uses scientific language, conventions and correctly labelled diagrams to explain properties, structures and behaviours of substances.

Selects, manipulates and assesses the relevance of scientific information from a variety of sources to support a point of view.

Analyses issues, organises information and presents clear and logical responses which are supported by evidence.

Identifies different types of substances. Identifies different reactions and correctly predicts their products.

Science inquiry skills

Formulates a hypothesis that states the relationship between dependent and independent variables.

Plans an investigation to collect appropriate data. Identifies controlled variables with specific detail.

Provides a clear and logical experimental procedure with sufficient detail to allow the investigation to be repeated by others.

Independently selects, and safely manipulates, appropriate apparatus and materials to obtain accurate results.

Organises data logically and presents it in a range of forms, including appropriate graphs and tables.

Processes experimental data to describe trends and explains these using relevant scientific concepts.

Processes numerical data using appropriate units to identify patterns and relationships.

Uses evidence to make and justify conclusions that relate to the hypothesis.

Evaluates experimental method and makes relevant comprehensive suggestions to improve the design of the investigation.

Communicates information and concepts logically, using correct scientific language, conventions and formats, including chemical symbols and formulae, and simple chemical equations.

B

Understanding and applying concepts

Applies chemical models and principles to describe and partially explain properties, structures and behaviours of substances.

Uses scientific language, conventions and appropriate diagrams to explain properties, structures and behaviours of substances.

Provides scientific information from a variety of sources to support a point of view.

Organises information and presents responses or statements which are not always well supported by evidence.

Identifies different types of substances. Identifies different types of reactions and correctly predicts their products.

Science inquiry skills

Formulates a hypothesis that states the relationship between dependent and independent variables.

Plans an investigation to collect appropriate data. Identifies some controlled variables without detail. Provides an experimental procedure that lacks detail. Independently selects, and safely manipulates, appropriate apparatus and materials.

Presents data in a range of forms, including appropriate graphs and tables.

Describes trends and briefly explains these using relevant scientific concepts. Processes numerical data using appropriate units to identify patterns. Makes conclusions that relate to the hypothesis. Evaluates experimental method and makes some suggestions to improve the design of the investigation.

Communicates information and concepts logically, generally using scientific language and formats including chemical symbols and formulae, word equations and some simple chemical equations.

Makes some errors in the use of conventions.

C

Understanding and applying concepts

Describes properties, structures and behaviours of substances, and provides a general explanation of them.

Uses some scientific language, conventions and diagrams to explain properties, structures and behaviours of substances.

Selects some scientific information to support a point of view.

Presents general statements supported by some evidence including some irrelevant or incorrect information.

Identifies different types of substances. When given reactants for reaction types can predict some products.

Science inquiry skills

Provides a statement that links dependent and independent variables without giving their relationship, within a context that has been provided.

Plans an investigation to collect appropriate data. Inconsistently controls variables.

Outlines the main steps in the experimental procedure.

Independently selects some appropriate apparatus and materials and uses them safely.

Presents data using basic tables and graphs.

Describes trends in the data with limited processing of numerical data.

Draws general conclusions that may not be linked to the hypothesis.

Describes difficulties experienced in conducting the investigation and suggests general improvements.

Communicates information and concepts, without detail, using some scientific language and conventions, for example, word equations. Responses are often not supported by appropriate examples.

D

Understanding and applying concepts

Describes properties and behaviours of substances with some irrelevant or incorrect information.
Describes some concepts using everyday language and provides simple diagrams.
Selects inappropriate scientific information or makes little use of evidence to support a point of view.
Provides responses which are often incomplete and include irrelevant or incorrect information.
Identifies some types of substances.

Science inquiry skills

Makes a simple prediction for an investigation. Does not distinguish between dependent, independent and controlled variables.
Plans an investigation that will not test their prediction/hypothesis. Follows a provided experimental procedure to collect data.
With guidance, selects appropriate apparatus and materials and uses them safely.
Presents data that is disorganised and lacks appropriate processing. Provides incomplete or incorrect tables and graphs.
Identifies trends in the data incorrectly or overlooks trends.
Offers conclusions that are not supported by the data.
Identifies difficulties experienced in conducting the investigation.
Communicates information using everyday language with frequent errors in the use of conventions.

E

Does not meet the requirements of a D grade and/or has completed insufficient assessment tasks to be assigned a higher grade.

Appendix 2 – 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 scientific statement based on the available information that can be tested by experimentation. When appropriate, the statement expresses an expected relationship between the independent and dependent variables for observed phenomena.
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.