CHEMISTRY
STAGE 6

DRAFT SYLLABUS FOR CONSULTATION

20 JULY – 31 AUGUST 2016

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THE BOSTES SYLLABUS DEVELOPMENT PROCESS

BOSTES began its syllabus development process for Stage 6 English, Mathematics, Science and History in 2014. This followed state and territory Education Ministers' endorsement of senior secondary Australian curriculum.

The development of the Stage 6 syllabuses involved expert writers and opportunities for consultation with teachers and other interest groups across NSW in order to receive the highest-quality advice across the education community.

A number of key matters at consultations were raised, including the need for the curriculum to cater for the diversity of learners, the broad range of students undertaking Stage 6 study in NSW, development of skills and capabilities for the future, school-based assessment and providing opportunities for assessing and reporting student achievement relevant for post-school pathways.

There was broad support that changes to curriculum and assessment would contribute to the reduction of student stress. BOSTES will continue to use NSW credentialling processes aligned with Stage 6 assessment and HSC examination structures.

A summary of the BOSTES syllabus development process is available at http://www.boardofstudies.nsw.edu.au/syllabuses/syllabus-development.

ASSISTING RESPONDENTS

The following icons are used to assist respondents:

 for your information	This icon indicates general information that assists in reading or understanding the information contained in the document. Text introduced by this icon will not appear in the final syllabus.
 consult	This icon indicates material on which responses and views are sought through consultation.

CONSULTATION

The *Chemistry Stage 6 Draft Syllabus* is accompanied by an online consultation survey on the BOSTES website. The purpose of the survey is to obtain detailed comments from individuals and systems/organisations on the syllabus. Please comment on both the strengths and the weaknesses of the draft syllabus. Feedback will be considered when the draft syllabus is revised.

The consultation period is from 20 July to 31 August 2016.

Written responses may be forwarded to:

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INTRODUCTION

STAGE 6 CURRICULUM

Board of Studies, Teaching and Educational Standards NSW (BOSTES) Stage 6 syllabuses have been developed to provide students with opportunities to further develop skills which will assist in the next stage of their lives, whether that is academic study, vocational education or employment.
The purpose of the Higher School Certificate program of study is to:

- provide a curriculum structure which encourages students to complete secondary education
- foster the intellectual, social and moral development of students, in particular developing their:
  - knowledge, skills, understanding, values and attitudes in the fields of study they choose
  - capacity to manage their own learning
  - desire to continue learning in formal or informal settings after school
  - capacity to work together with others
  - respect for the cultural diversity of Australian society
- provide a flexible structure within which students can prepare for:
  - further education and training
  - employment
  - full and active participation as citizens
- provide formal assessment and certification of students' achievements
- provide a context within which schools also have the opportunity to foster students' physical and spiritual development.

The Stage 6 syllabuses reflect the principles of the BOSTES *K–10 Curriculum Framework* and *Statement of Equity Principles*, and the *Melbourne Declaration on Educational Goals for Young Australians* (December 2008). The syllabuses build on the continuum of learning developed in the K–10 syllabuses.

The Stage 6 syllabuses provide a set of broad learning outcomes that summarise the knowledge, understanding, skills, values and attitudes essential for students to succeed in and beyond their schooling. In particular, the literacy and numeracy skills needed for future study, employment and life are provided in Stage 6 syllabuses in alignment with the *Australian Core Skills Framework (ACSF)*.

The syllabuses have considered agreed Australian curriculum content and included content that clarifies the scope and depth of learning in each subject.

Stage 6 syllabuses support a standards-referenced approach to assessment by detailing the essential knowledge, understanding, skills, values and attitudes students will develop and outlining clear standards of what students are expected to know and be able to do. In accordance with the *Statement of Equity Principles*, Stage 6 syllabuses take into account the diverse needs of all students. The syllabuses provide structures and processes by which teachers can provide continuity of study for all students.

DIVERSITY OF LEARNERS

NSW Stage 6 syllabuses are inclusive of the learning needs of all students. Syllabuses accommodate teaching approaches that support student diversity including Students with special education needs, Gifted and talented students and Students learning English as an additional language or dialect (EAL/D).

STUDENTS WITH SPECIAL EDUCATION NEEDS

All students are entitled to participate in and progress through the curriculum. Schools are required to provide additional support or adjustments to teaching, learning and assessment activities for some students. Adjustments are measures or actions taken in relation to teaching, learning and assessment that enable a student to access syllabus outcomes and content and demonstrate achievement of outcomes.

Students with special education needs can access the Stage 6 outcomes and content in a range of ways. Students may engage with:

- syllabus outcomes and content with adjustments to teaching, learning and/or assessment activities
- selected outcomes and content appropriate to their learning needs
- selected Stage 6 Life Skills outcomes and content appropriate to their learning needs.

Decisions regarding adjustments should be made in the context of collaborative curriculum planning with the student, parent/carer and other significant individuals to ensure that syllabus outcomes and content reflect the learning needs and priorities of individual students.

Further information can be found in support materials for:

- Science
- Special education needs
- Life Skills.

GIFTED AND TALENTED STUDENTS

Gifted students have specific learning needs that may require adjustments to the pace, level and content of the curriculum. Differentiated educational opportunities assist in meeting the needs of gifted students.

Generally, gifted students demonstrate the following characteristics:

- the capacity to learn at faster rates
- the capacity to find and solve problems
- the capacity to make connections and manipulate abstract ideas.

There are different kinds and levels of giftedness. Gifted and talented students may also possess learning difficulties and/or disabilities that should be addressed when planning appropriate teaching, learning and assessment activities.

Curriculum strategies for gifted and talented students may include:

- differentiation: modifying the pace, level and content of teaching, learning and assessment activities
- acceleration: promoting a student to a level of study beyond their age group
- curriculum compacting: assessing a student's current level of learning and addressing aspects of the curriculum that have not yet been mastered.

School decisions about appropriate strategies are generally collaborative and involve teachers, parents and students with reference to documents and advice available from BOSTES and the education sectors.

Gifted and talented students may also benefit from individual planning to determine the curriculum options, as well as teaching, learning and assessment strategies, most suited to their needs and abilities.

STUDENTS LEARNING ENGLISH AS AN ADDITIONAL LANGUAGE OR DIALECT (EAL/D)

Many students in Australian schools are learning English as an additional language or dialect (EAL/D). EAL/D students are those whose first language is a language or dialect other than Standard Australian English and who require additional support to assist them to develop English language proficiency.

EAL/D students come from diverse backgrounds and may include:

- overseas and Australian-born students whose first language is a language other than English, including creoles and related varieties
- Aboriginal and Torres Strait Islander students whose first language is Aboriginal English, including Kriol and related varieties.

EAL/D students enter Australian schools at different ages and stages of schooling and at different stages of Australian Standard English language learning. They have diverse talents and capabilities and a range of prior learning experiences and levels of literacy in their first language and in Australian Standard English. EAL/D students represent a significant and growing percentage of learners in NSW schools. For some, school is the only place they use Australian Standard English.

EAL/D students are simultaneously learning a new language and the knowledge, understanding and skills of the Chemistry Stage 6 syllabus through that new language. They require additional time and support, along with informed teaching that explicitly addresses their language needs, and assessments that take into account their developing language proficiency.

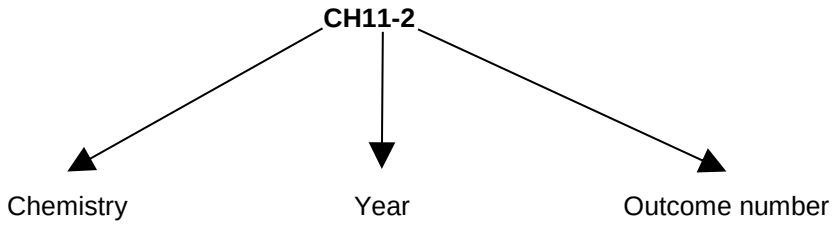
CHEMISTRY KEY

The following codes and icons are used in the *Chemistry Stage 6 Draft Syllabus*.

OUTCOME CODING

Syllabus outcomes have been coded in a consistent way. The code identifies the subject, year and outcome number.

In the *Chemistry Stage 6 Draft Syllabus*, outcome codes indicate the subject, year and outcome number, for example:

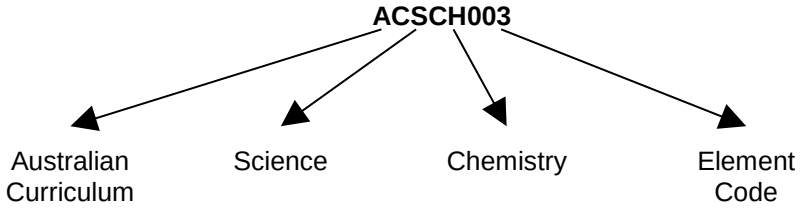


Outcome code	**Interpretation**
CH11-1	Chemistry, Year 11 – Outcome number 1
CH12-4	Chemistry, Year 12 – Outcome number 4

CODING OF AUSTRALIAN CURRICULUM CONTENT

Australian curriculum content descriptions included in the syllabus are identified by an Australian curriculum code which appears in brackets at the end of each content description, for example:

> Conduct investigations, including the use of devices to accurately measure temperature change and mass, safely, competently and methodically for the collection of valid and reliable data (ACSCH003).



Where a number of content descriptions are jointly represented, all description codes are included, eg (ACSCH001, ACSCH002, ACSCH003).

LEARNING ACROSS THE CURRICULUM ICONS

Learning across the curriculum content, including cross-curriculum priorities, general capabilities and other areas identified as important learning for all students, is incorporated and identified by icons in the *Chemistry Stage 6 Draft Syllabus*.

Cross-curriculum priorities	
	Aboriginal and Torres Strait Islander histories and cultures
	Asia and Australia's engagement with Asia
	Sustainability
General capabilities	
	Critical and creative thinking
	Ethical understanding
	Information and communication technology capability
	Intercultural understanding
	Literacy
	Numeracy
	Personal and social capability
Other learning across the curriculum areas	
	Civics and citizenship
	Difference and diversity
	Work and enterprise

RATIONALE

 for your information

The rationale describes the distinctive nature of the subject and outlines its relationship to the contemporary world and current practice. It explains the place and purpose of the subject in the curriculum, including:

- why the subject exists
- the theoretical underpinnings
- what makes the subject distinctive
- why students would study the subject
- how it contributes to the purpose of the Stage 6 curriculum
- how it prepares students for post-school pathways.

 consult

The Chemistry Stage 6 course explores the structure, composition and reactions of and between all elements, compounds and mixtures that exist in the Universe. The discovery and synthesis of new compounds, the monitoring of elements and compounds in the environment and an understanding of industrial processes and their applications to life processes are central to our ability to develop future industries, human progress and sustainability.

Chemistry not only incorporates Working Scientifically processes to develop skills, it also focuses upon the exploration of models, the understanding of theories and laws and encourages an examination of the connectedness between seemingly dissimilar phenomena.

Chemistry involves using differing scales, specialised representations, explanations, predictions and creativity, especially in the development and pursuit of new materials. It requires students of Chemistry to use their imagination to visualise the dynamic minuscule world of atoms in order to gain a better understanding of how chemicals interact.

The Chemistry course builds upon students' knowledge and skills gained in Science Stage 5 and develops a greater understanding of chemistry as a foundation for undertaking investigations in a wide range of scientific fields. A knowledge and understanding of chemistry often provides the unifying link across interdisciplinary studies.

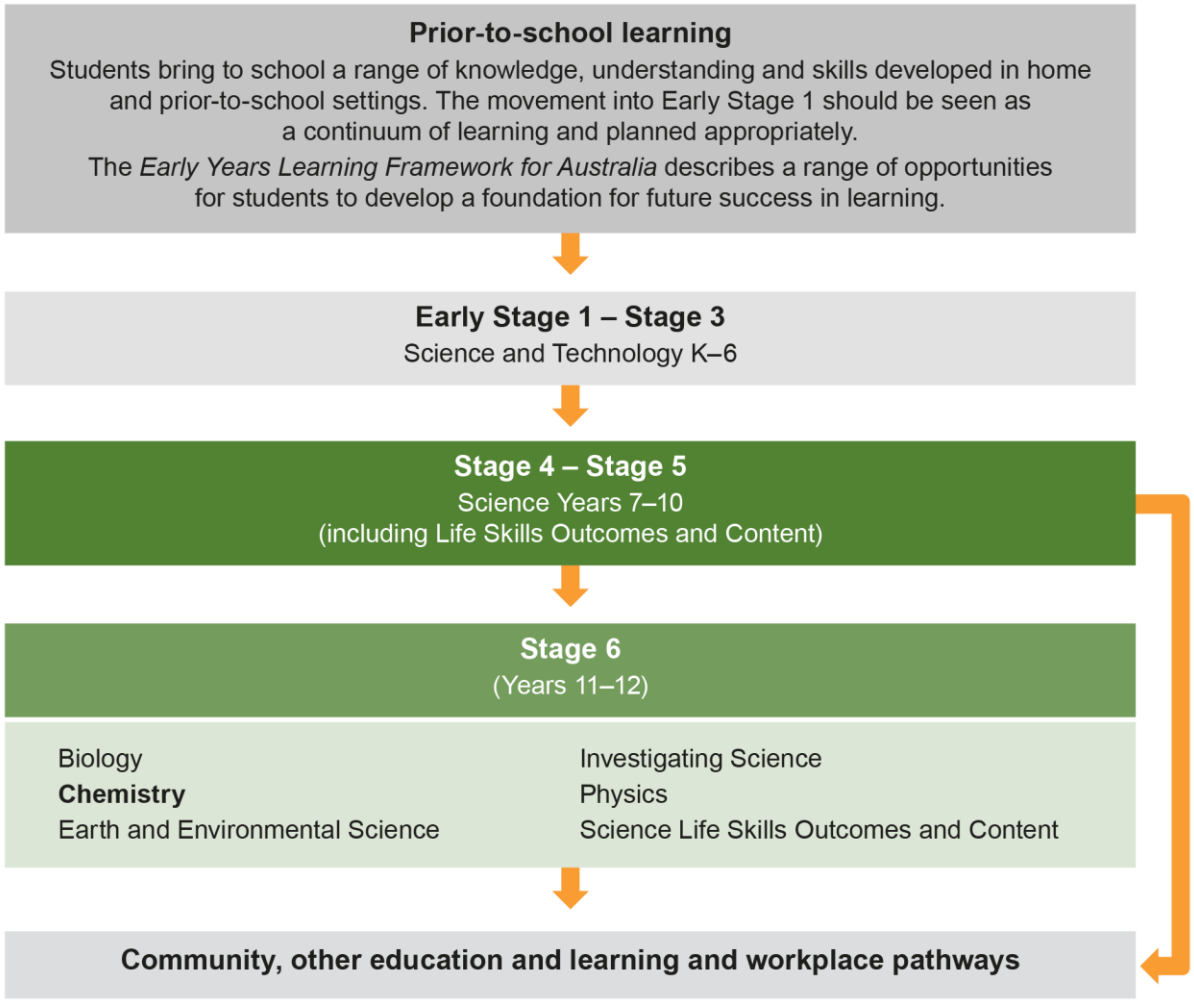
The study of chemistry provides the foundation knowledge and skills required to study Chemistry post-school and supports participation in a range of careers in chemistry and related interdisciplinary industries. It is an essential discipline that addresses energy, development of new materials and sustainability.

THE PLACE OF THE CHEMISTRY STAGE 6 DRAFT SYLLABUS IN THE K–12 CURRICULUM

for your information

NSW syllabuses include a diagram that illustrates how the syllabus relates to the learning pathways in K–12. This section places the Chemistry Stage 6 syllabus in the K–12 curriculum as a whole.

consult



AIM

 for your information

In NSW syllabuses, the aim provides a succinct statement of the overall purpose of the syllabus. It indicates the general educational benefits for students from programs based on the syllabus.

The aim, objectives, outcomes and content of a syllabus are clearly linked and sequentially amplify details of the intention of the syllabus.

 consult

The study of Chemistry in Stage 6 enables students to develop an appreciation and understanding of materials and their properties, structures, interactions and related applications. Through applying Working Scientifically processes, the course aims to examine how chemical theories, models and practices are used and developed.

OBJECTIVES

 for your information

In NSW syllabuses, objectives provide specific statements of the intention of a syllabus. They amplify the aim and provide direction to teachers on the teaching and learning process emerging from the syllabus. They define, in broad terms, the knowledge, understanding, skills, values and attitudes to be developed through study in the subject. They act as organisers for the intended outcomes.

 consult

VALUES AND ATTITUDES

Students:

- develop positive, informed values and attitudes towards Chemistry
- recognise the importance and relevance of chemistry in their lives
- recognise the influence of economic, political and societal impacts on the development of scientific knowledge
- develop an appreciation of the influence of imagination and creativity in scientific research

SKILLS

Students:

- develop skills in applying the processes of Working Scientifically

KNOWLEDGE AND UNDERSTANDING

Students:

- develop knowledge and understanding of the fundamentals of chemistry
- develop knowledge and understanding of the trends and driving forces in chemical interaction
- develop knowledge and understanding of equilibrium and acid reactions in chemistry
- develop knowledge and understanding of the applications of chemistry

OUTCOMES

 for your information

In NSW syllabuses, outcomes provide detail about what students are expected to achieve at the end of each Year in relation to the objectives. They indicate the knowledge, understanding and skills expected to be gained by most students as a result of effective teaching and learning. They are derived from the objectives of the syllabus.

 consult

TABLE OF OBJECTIVES AND OUTCOMES – CONTINUUM OF LEARNING

SKILLS

Objective Students: • develop skills in applying the processes of Working Scientifically	
Year 11 course outcomes A student:	**Year 12 course outcomes** A student:
Questioning **CH11-1** poses questions and hypotheses for scientific investigation	**Questioning** **CH12-1** develops and evaluates questions and hypotheses for scientific investigation
Designing investigations **CH11-2** designs and plans appropriate scientific investigations	**Designing investigations** **CH12-2** designs, plans and evaluates primary and secondary-sourced investigations
Conducting investigations **CH11-3** conducts primary or secondary-sourced investigations individually or in a team.	**Conducting investigations** **CH12-3** conducts primary and secondary-sourced investigations individually or in a team
Representing **CH11-4** represents qualitative and quantitative data and information using a range of appropriate media.	**Representing** **CH12-4** selects and represents key qualitative and quantitative data and information using a range of appropriate media
Analysing **CH11-5** analyses primary and secondary information sources	**Analysing** **CH12-5** analyses primary and secondary information sources

Solving problems **CH11-6** solves scientific problems	**Solving problems** **CH12-6** solves scientific problems using primary and secondary data
Communicating **CH11-7** communicates scientific understanding	**Communicating** **CH12-7** communicates scientific understanding using suitable language and terminology

The Skills outcomes found at the beginning of each module are targeted for emphasis. It is recognised that the other Skills outcomes will also be addressed in each module.

KNOWLEDGE AND UNDERSTANDING

Year 11 course Unit 1	**Year 12 course Unit 3**
Objective Students: ● develop knowledge and understanding of the fundamentals of chemistry	**Objective** Students: ● develop knowledge and understanding of equilibrium and acid reactions in chemistry
Year 11 course outcomes A student:	**Year 12 course outcomes** A student:
CH11-8 explores the properties and trends in the physical, structural and chemical aspects of matter	**CH12-8** explains the characteristics of equilibrium systems, and the factors that affect these systems
CH11-9 describes, applies and quantitatively analyses the mole concept and stoichiometric relationships	**CH12-9** describes, explains and quantitatively analyses acids and bases using contemporary models
Year 11 course Unit 2	**Year 12 course Unit 4**
Objective Students: ● develop knowledge and understanding of the trends and driving forces in chemical interactions	**Objective** Students: ● develop knowledge and understanding of the applications of chemistry
Year 11 course outcomes A student:	**Year 12 course outcomes** A student:
CH11-10 explores the many different types of chemical reactions, in particular the reactivity of metals, and the factors that affect the rate of chemical reactions	**CH12-10** analyses the structure and predicts reactions involving carbon compounds
CH11-11 analyses the energy considerations in the driving force for chemical reactions	**CH12-11** describes and evaluates chemical systems used to design and analyse chemical processes

WORKING SCIENTIFICALLY

Working Scientifically skills are at the core of conducting primary and secondary-sourced investigations in science.

Opportunities for students are to be provided for students to engage with all the Working Scientifically skills for each investigation. In each module, particular outcomes have been identified as those that are most relevant to the intended learning.

In Stage 6 students are challenged to further develop their understanding of Working Scientifically as a group of dynamic and interdependent processes that are applied in each scientific investigation in a way that is appropriate for the task. This dynamism and interrelatedness adds a level of sophistication to students' understanding of the true nature and practice of science. Through regular involvement in these processes, applying them as they arise, in a range of varied primary investigations, students will broaden their interpretation of Working Scientifically beyond the common linear model that suggests science is a process that simply confirms the way things are.

Students, through a variety of activities, are encouraged to select the most appropriate gateway to the Working Scientifically processes. These gateways become self-evident through the nature of the investigation. An inquiry may be instigated, for example, by direct observation of a phenomenon, or emerge from inconsistencies in results, from quantitative and/or qualitative analysis of data or from secondary research previously conducted by others. Students are challenged to be open to refining or redeveloping their chosen procedures, redefining their questions and/or hypotheses, modifying their methodologies or designs, conducting further secondary research and encouraged to communicate evidence-based conclusions and novel ideas for future research. The processes are informed by the unexpected. Unexpected results are to be used to further inform the pathway towards scientific truth. Knowledge and understanding of science is essential to these processes being performed and, in turn, a deeper knowledge and understanding of scientific concepts emerges from students learning through the practice of science.

Each of the seven Working Scientifically outcomes represents a part of the interdependent dynamic process and its centrality to the study of science and the acquisition of scientific knowledge and skills. This course is structured to provide ongoing opportunities for students to implement these processes, particularly through the depth study provision. The following descriptions of these outcomes provide further information about the skills students are expected to develop throughout the course.

Questioning
Developing, proposing and evaluating inquiry questions and hypotheses challenge students to identify an area that can be investigated scientifically, involving primary and/or secondary-sourced data. Students demonstrate the development of inquiry question(s) that require observations, experimentation and/or research to aid in constructing a reasonable and informed hypothesis. The consideration of variables is to be included in the questioning process.

Designing investigations
In designing investigations, students ensure that all risks are assessed, appropriate materials and technologies are sourced and that all ethical concerns are considered. Variables are to be identified as independent, dependent and controlled to ensure a procedure is developed that will allow for the reliable collection of data. Investigations are to include strategies that ensure that controlled variables are kept constant. Students justify and evaluate the design of investigations.

Conducting investigations
Students are to select appropriate equipment, employ safe work practices and ensure that risk assessments are conducted and followed. Appropriate technologies are to be used and procedures followed when disposing of waste. The selection and criteria for collecting valid and reliable data is to be methodical and, where appropriate, secondary-sourced information is referenced correctly. Reliability is ensured by making modifications to procedure and repeating the investigation or referring to other reliable secondary sources. Accuracy is ensured by using appropriate technologies in a consistent manner.

Representing
In representing data and information, students use the most appropriate and meaningful methods and media to organise and analyse data and information sources, including digital technologies and the use of a variety of visual representations. From these representations students identify trends, patterns and relationships in data and information and recognise error, uncertainty and limitations. Representations are to communicate data and information in order to help solve problems. They make predictions and assist in synthesising data and information to develop evidence-based conclusions and arguments.

Analysing
Students identify trends, patterns and relationships; recognise error, uncertainty and limitations in data; and interpret scientific and media texts. Students evaluate the relevance, accuracy, validity and reliability of the primary or secondary-sourced data in relation to investigations. They evaluate processes, claims and conclusions by considering the quality of available evidence; and use reasoning to construct scientific arguments. Where appropriate, mathematical models should be constructed and calculations applied to best demonstrate the trends and relationships that occur in data.

Solving problems
Students use critical thinking skills and creativity to demonstrate an understanding of scientific principles underlying the solutions to inquiry questions and problems posed in investigations. Appropriate and varied strategies are employed including using models to quantitatively and qualitatively explain and predict cause and effect relationships. In Working Scientifically, students synthesise and use evidence to construct and justify conclusions. Students interpret scientific and media texts and evaluate processes, claims and conclusions and consider the quality of available evidence to solve problems.

Communicating

Communicating all components of the Working Scientifically processes with clarity and accuracy is essential. Students use qualitative and quantitative information gained from primary and secondary-sourced investigations including digital, visual, written and verbal forms of communication as appropriate. Students apply appropriate scientific notations, nomenclature and scientific language where appropriate and use scientific language suitable for specific audiences and contexts.

INVESTIGATIONS

Primary and secondary-sourced investigations emphasise a range of types of practical activities and may include:

- undertaking laboratory investigations, including fair tests and controlled experiments
- undertaking fieldwork and surveys
- researching by using a variety of print and multimedia, as well as internet and electronic sources of data and information
- using a range of strategies and technologies to collect and record data, including appropriate use of digital technologies
- using and constructing models
- using or reorganising second-hand data, including those in spreadsheets and databases
- extracting and reorganising information in the form of flow charts, tables, graphs, diagrams, prose, keys, spreadsheets and databases
- using digital technologies, eg computer animations and simulations, to capture and analyse data and information
- presenting data and information in multimodal texts.

COURSE STRUCTURE AND REQUIREMENTS

 for your information

The following provides an outline of the Year 11 and Year 12 course structure and requirements for the *Chemistry* i *Draft Syllabus* with indicative hours, arrangement of content, and an overview of course content.

 consult

<table>
<tr><td rowspan="8">Year 11 course (120 hours)</td><td rowspan="14">Working Scientifically Skills</td><td>Unit</td><td colspan="2">Module</td><td>Indicative hours</td></tr>
<tr><td rowspan="2">Unit 1
Fundamentals of Chemistry</td><td colspan="2">Module 1
Properties and structure of matter</td><td rowspan="2">45–60</td></tr>
<tr><td colspan="2">Module 2
Introduction to Quantitative Chemistry</td></tr>
<tr><td colspan="3">Depth study
Drawn from knowledge outcome(s) in Unit 1 and/or 2</td><td>15</td></tr>
<tr><td rowspan="2">Unit 2
Chemical Interactions and Driving Forces</td><td colspan="2">Module 3
Reactive chemistry</td><td rowspan="2">45–60</td></tr>
<tr><td colspan="2">Module 4
Drivers of reactions</td></tr>
<tr><td rowspan="6">Year 12 course (120 hours)</td><td rowspan="2">Unit 3
Equilibrium and Acids</td><td colspan="2">Module 5
Equilibrium reactions</td><td rowspan="2">45–60</td></tr>
<tr><td colspan="2">Module 6
Acid/Base reactions</td></tr>
<tr><td colspan="3">Depth study
Drawn from knowledge outcome(s) in Unit 3 and/or 4</td><td>15</td></tr>
<tr><td rowspan="2">Unit 4
Applications of Chemistry</td><td colspan="2">Module 7
Organic Chemistry</td><td rowspan="2">45–60</td></tr>
<tr><td colspan="2">Module 8
Applying chemical ideas</td></tr>
</table>

DEPTH STUDY: YEARS 11 AND 12

What are depth studies?

A depth study is any type of investigation/activity that a student completes individually or collaboratively that allows extension of one or more concepts found within or inspired by the syllabus. It may be one investigation/activity or a series of investigations/activities. Depth studies must address at least one knowledge outcome, the Questioning and Communicating skills outcomes and at least two other skills outcomes.

Depth studies allow students the avenue to pursue interests, to acquire a depth of understanding and to take responsibility for their own learning. They promote differentiation, engagement, ongoing feedback and support all forms of assessment.

A depth study may be, but is not limited to:

- a primary investigation or a series of primary investigations
- a secondary-sourced investigation or series of secondary-sourced investigations
- presentations, research assignments or fieldwork reports
- extension of concepts found within the course, either qualitatively and/or quantitatively.

A minimum of 15 hours per year of in-class course time is to be allocated to depth studies. The length of time for any individual study and pedagogies employed are not prescribed. The time for the depth study may be allocated to a single study or spread over the year and incorporate several studies depending on individual school and/or class requirements.

Requirements for depth studies

- A minimum of 15 hours of in-class time is allocated in each of Years 11 and 12.
- At least one depth study must be included in each of Years 11 and 12.
- Depth studies are to form part of the school-based assessment in each of Years 11 and 12.
- Depth studies must contribute a minimum of 20% to a maximum of 40% towards a student's school-based assessment in each of Years 11 and 12.
- The Working Scientifically outcomes of Questioning and Communicating must be addressed in the school-based assessment component in each of Years 11 and 12.
- A minimum of two additional Working Scientifically skills outcomes, and at least one knowledge outcome, are to be addressed in depth studies.

The following outcomes must be addressed in depth studies:

- Questioning and Communicating skills
- A minimum of two additional skills
- At least one Knowledge outcome

POSSIBLE DEPTH STUDIES

Primary investigations

- Design and conduct experiments
- Test a claim
- Test a device.

Secondary-sourced investigations

- Make a documentary or media report
- Conduct a literature review
- Develop an evidence-based argument
- Write a journal article
- Write an essay–historical or theoretical
- Develop an environmental management plan
- Analyse a work of fiction or film for scientific relevance
- Create a visual presentation
- Investigate emerging technologies.

Create

- Design and invent
- Create a working model
- Create a portfolio.

Fieldwork

Fieldwork may be a starting point for a primary investigation or secondary-sourced study and could be initiated by the following stimuli:

- an excursion
- engagement with community experts.

Data analysis

This could be incorporated into a primary investigation or secondary-sourced investigation, for example:

- constructing and analysing graphs/tables
- data analysis from a variety of sources
- analysing research, eg longitudinal data, resource management data.

ASSESSMENT

 for your information

The key purpose of assessment is to gather valid and useful information about student learning and achievement. It is an essential component of the teaching and learning cycle. School-based assessment provides opportunities to measure student achievement of outcomes in a more diverse way than the HSC examination.

BOSTES continues to promote a standards-referenced approach to assessing and reporting student achievement. Assessment for, as and of learning are important to guide future teaching and learning opportunities and to give students ongoing feedback. These approaches are used individually or together, formally or informally, to gather evidence of student achievement against standards. Assessment provides teachers with the information needed to make judgements about students' achievement of outcomes.

Ongoing stakeholder feedback, analysis of BOSTES examination data and information gathered about assessment practices in schools has indicated that school-based and external assessment requirements require review and clarification. The HSC Reforms outline changes to school-based and HSC assessment practices to:

- make assessment more manageable for students, teachers and schools
- maintain rigorous standards
- strengthen opportunities for deeper learning
- provide opportunities for students to respond to unseen questions, and apply knowledge, understanding and skills to encourage in-depth analysis
- support teachers to make consistent judgements about student achievement.

Students with special education needs

Some students with special education needs will require adjustments to assessment practices in order to demonstrate what they know and can do in relation to syllabus outcomes and content. The type of adjustments and support will vary according to the particular needs of the student and the requirements of the assessment activity. Schools can make decisions to offer adjustments to coursework and school-based assessment.

Life Skills

Students undertaking Years 11–12 Life Skills courses will study selected outcomes and content. Assessment activities should provide opportunities for students to demonstrate achievement in relation to the outcomes, and to apply their knowledge, understanding and skills to a range of situations or environments.

The following general descriptions have been provided for consistency. Further advice about assessment, including in support materials, will provide greater detail.

Assessment for Learning	• enables teachers to use formal and informal assessment activities to gather evidence of how well students are learning • teachers provide feedback to students to improve their learning • evidence gathered can inform the directions for teaching and learning programs.
Assessment as Learning	• occurs when students use self-assessment, peer-assessment and formal and informal teacher feedback to monitor and reflect on their own learning, consolidate their understanding and work towards learning goals.
Assessment of Learning	• assists teachers to use evidence of student learning to assess student achievement against syllabus outcomes and standards at defined key points within a Year or Stage of learning.
Formal assessment	• tasks which students undertake as part of the internal assessment program, for example a written examination, research task, oral presentation, performance or other practical task • tasks appear in an assessment schedule and students are provided with sufficient written notification • evidence is gathered by teachers to report on student achievement in relation to syllabus outcomes and standards, and may also be used for grading or ranking purposes.
Informal assessment	• activities undertaken and anecdotal evidence gathered by the teacher throughout the learning process in a less prescribed manner, for example class discussion, questioning and observation • used as part of the ongoing teaching and learning process to gather evidence and provide feedback to students • can identify student strengths and areas for improvement.
Written examination	• a task undertaken individually, under formal supervised conditions to gather evidence about student achievement in relation to knowledge, understanding and skills at a point in time, for example a half-yearly, yearly or trial HSC examination • a task which may include one or more unseen questions or items, assessing a range of outcomes and content.

consult

Chemistry Draft Assessment Requirements

The draft guidelines for school-based assessment provide specific advice about the number of formal assessment tasks, course components and weightings, and the nature of task types to be administered in Year 11 and Year 12.

The components and weightings for Year 11 and Year 12 are mandatory.

Year 11

- There will be 3 formal assessment tasks
- The maximum weighting for each formal assessment task is 40%
- One task may be a formal written examination
- One task must include an assessment of the depth study and its related knowledge, understanding and skills outcomes with a weighting of 20–40%
- A minimum of 25% weighting must be allocated to practical investigations.

Component	**Weighting %**
Skills in working scientifically	60
Knowledge and understanding of course content	40
	100

Year 12

- There will be no more than 4 formal assessment tasks
- The maximum weighting for each formal assessment task is 40%
- One task may be a formal written examination, eg a trial HSC, with a maximum weighting of 25%
- One task must include an assessment of the depth study and its related knowledge, understanding and skills outcomes with a weighting of 20–40%
- A minimum of 25% weighting must be allocated to practical investigations.

Component	**Weighting %**
Skills in working scientifically	60
Knowledge and understanding of course content	40
	100

Chemistry Draft Examination Specifications

Sections
Section I Objective response questions *Questions may include stimulus material*
Section II Short response questions which may include multiple sections *Questions may include stimulus material*

HSC examination specifications will be reviewed following finalisation of the syllabuses.

Updated assessment and reporting advice will be provided when syllabuses are released.

The Assessment Certification Examination website will be updated to align with the syllabus implementation timeline.

CONTENT

For Kindergarten to Year 12 courses of study and educational programs are based on the outcomes and content of syllabuses. The content describes in more detail how the outcomes are to be interpreted and used, and the intended learning appropriate for each Year. In considering the intended learning, teachers will make decisions about the emphasis to be given to particular areas of content, and any adjustments required based on the needs, interests and abilities of their students.

The knowledge, understanding and skills described in the outcomes and content provide a sound basis for students to successfully transition to their selected post-school pathway.

LEARNING ACROSS THE CURRICULUM

for your information

NSW syllabuses provide a context within which to develop core skills, knowledge and understanding considered essential for the acquisition of effective, higher-order thinking skills that underpin successful participation in further education, work and everyday life including problem-solving, collaboration, self-management, communication and information technology skills.

BOSTES has described learning across the curriculum areas that are to be included in syllabuses. In Stage 6 syllabuses, the identified areas will be embedded in the descriptions of content and identified by icons. Learning across the curriculum content, including the cross-curriculum priorities and general capabilities, assists students to achieve the broad learning outcomes defined in the BOSTES *Statement of Equity Principles*, the *Melbourne Declaration on Educational Goals for Young Australians* (December 2008) and in the *Australian Government's Core Skills for Work Developmental Framework* (2013).

Knowledge, understanding, skills, values and attitudes derived from the learning across the curriculum areas will be included in BOSTES syllabuses, while ensuring that subject integrity is maintained.

Cross-curriculum priorities enable students to develop understanding about and address the contemporary issues they face.

The cross-curriculum priorities are:
- Aboriginal and Torres Strait Islander histories and cultures
- Asia and Australia's engagement with Asia
- Sustainability

General capabilities encompass the knowledge, skills, attitudes and behaviours to assist students to live and work successfully in the 21st century.

The general capabilities are:
- Critical and creative thinking
- Ethical understanding
- Information and communication technology capability
- Intercultural understanding
- Literacy
- Numeracy
- Personal and social capability

BOSTES syllabuses include other areas identified as important learning for all students:

- Civics and citizenship
- Difference and diversity
- Work and enterprise

 consult

Aboriginal and Torres Strait Islander histories and cultures

Aboriginal and Torres Strait Islander communities have diverse cultures, social structures and a history of unique, complex knowledge systems. Students are provided with opportunities to learn about how Aboriginal and Torres Strait Islander peoples have developed and refined knowledge about the world through observation, making predictions, testing (trial and error) and responding to environmental factors within specific contexts. Students will investigate examples of Aboriginal and Torres Strait Islander peoples' understanding of the environment and the ways that traditional knowledge and western scientific knowledge can be complementary.

When planning and programming content relating to Aboriginal and Torres Strait Islander histories and cultures teachers are encouraged to consider involving local Aboriginal communities and/or appropriate knowledge holders in determining suitable resources, or to use Aboriginal or Torres Strait Islander authored or endorsed publications.

Asia and Australia's engagement with Asia

Asia and Australia's engagement with Asia provides rich and engaging contexts for developing students' science and technology skills, knowledge and understanding. Students are provided with opportunities to recognise that the Asia region includes diverse environments. Students appreciate how interactions within and between these environments and the impacts of human activity influence the region, including Australia, and have significance for the rest of the world.

The Asia region plays an important role in scientific and technological research and development in areas such as medicine, natural resource management and natural disaster prediction and management.

Sustainability

Sustainability is concerned with the ongoing capacity of the Earth to maintain all life. It provides authentic contexts for exploring, investigating and understanding systems in the natural and made environments. Students are provided with opportunities to investigate relationships between systems and system components, and consider the sustainability of food sources and the natural and human environments. Students will engage with ethical debate and learn to engage with different perspectives in solving ethical problems.

Critical and creative thinking

Critical and creative thinking are integral to activities where students learn to generate and evaluate knowledge, clarify concepts and ideas, seek possibilities, consider alternatives and solve problems. Critical and creative thinking are embedded in the skills and processes of Working Scientifically and Working Technologically. Students are provided with opportunities to develop critical and creative thinking skills through asking and posing questions, making predictions, engaging in primary and secondary source investigations and analysing and evaluating evidence in order to making evidence-based decisions.

Ethical understanding

Students develop the capability to assess ethical values and principles, and understand how reasoning can assist ethical judgement. Students are provided with opportunities for students to form and make ethical judgements in relation to scientific investigations, design, codes of practice, and the use of scientific information and applications. Students explore the importance of reporting honestly based on evidence. They apply ethical guidelines in their investigations, particularly in their implications for others and the environment.

Information and communication technology capability

Information and communication technology (ICT) can be used effectively and appropriately to access, create and communicate information and ideas, model interactions, solve problems and work collaboratively. Students are provided with opportunities to develop ICT capability when they develop ideas, concepts and solutions, research science concepts and applications, investigate scientific phenomena, and communicate their scientific and technological understandings. In particular they learn to access information, collect, analyse and represent data, model and interpret concepts and relationships, and communicate scientific and technological ideas, processes and information.

Intercultural understanding

Students develop intercultural understanding as they learn to understand themselves in relation to others. This involves students valuing their own cultures and those of others, and engaging with people of diverse cultures in ways that recognise commonalities and differences, create connections and cultivate respect. Students are provided with opportunities to appreciate how diverse cultural perspectives have impacted on the development, breadth and diversity of scientific knowledge and applications. Students learn about and engage with issues requiring cultural sensitivity, and that scientists work in culturally diverse teams to address issues and solve problems of national and international importance.

Literacy

Literacy is the ability to use a repertoire of knowledge and skills to communicate and comprehend effectively, using a variety of modes and media. Being ‘literate’ is more than the acquisition of technical skills – it includes the ability to identify, understand, interpret, create and communicate effectively using written, visual and digital forms of expression and communication for a number of purposes. Students are provided with opportunities to understand that language varies according to the context and engage with different forms of written and spoken language to communicate scientific concepts. Students learn that scientific information can also be presented in the form of diagrams, flowcharts, tables, graphs and models.

Numeracy

Numeracy involves students in recognising and understanding the role of Mathematics in the world. Students become numerate as they develop the confidence, willingness and ability to apply mathematics in their lives in constructive and meaningful ways. Students are provided with opportunities to develop numeracy skills through practical measurement and the collection, representation and interpretation of data from first-hand investigations and secondary sources. Students consider issues of uncertainty and reliability in measurement and learn data-analysis skills, identifying trends and patterns from numerical data and graphs. Students will apply mathematical equations and concepts in order to solve problems.

Personal and social capability

Students develop personal and social capability as they learn to understand and manage themselves, their relationships and their lives more effectively. This includes establishing positive relationships, making responsible decisions, working effectively individually and in teams and constructively handling challenging situations. Through applying the processes of Working Scientifically students develop skills in collaboration, peer assessment and review. Students learn to plan and conduct a depth study either individually or in a team.

Civics and citizenship

Civics and citizenship content involves knowledge and understanding of how our Australian society operates. Students are provided with opportunities to broaden their understanding of aspects of civics and citizenship in relation to the application of science ideas and technological advances, including ecological sustainability and the development of environmental and sustainable practices at a local, regional and national level.

Difference and diversity

Difference and diversity comprise gender, race and socio-economic circumstances. Students are provided with opportunities for students to understand and appreciate the difference and diversity they experience in their everyday lives. Working Scientifically and Working Technologically provide opportunities for students to work collaboratively, where they can develop an appreciation of the values and ideas of all group members. This also enables them to identify individual rights, challenge stereotypes and engage with opinions different to their own.

Work and enterprise

Students develop work-related skills and an appreciation of the value of working individually and collaboratively when conducting investigations. Students are provided with opportunities for students to prioritise safe practices and understand the potential risks and hazards present when conducting investigations. They engage with risk assessment whilst working safely in the laboratory or in the field.

ORGANISATION OF CONTENT

for your information

The following provides a diagrammatic representation of the relationships between syllabus content.

consult

The Working Scientifically outcomes and content are to be integrated into each module wherever students undertake an investigation.

CHEMISTRY YEAR 11 COURSE CONTENT

 consult

WORKING SCIENTIFICALLY SKILLS

The following Working Scientifically outcomes and content are to be integrated into each module wherever students undertake an investigation

1. QUESTIONING

OUTCOMES

A student:

> poses questions and hypotheses for scientific investigation CH11-1

CONTENT

Students:

- develop and propose inquiry questions and hypotheses to identify an area that can be investigated scientifically, involving primary and/or secondary source data (ACSBL001)

2. DESIGNING INVESTIGATIONS

OUTCOMES

A student:

> designs and plans appropriate scientific investigations CH11-2

CONTENT

Students:

- assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning investigations (ACSBL031)
- include the use of variables and experimental controls to ensure that a valid procedure is developed that allows for the reliable collection of data (ACSBL002)

3. CONDUCTING INVESTIGATIONS

OUTCOMES

A student:

> conducts primary or secondary-sourced investigations individually or in a team CH11-3

CONTENT

Students:

- employ safe work practices and manage risks (ACSBL031)
- use appropriate technologies to ensure accuracy
- select and extract information from reliable secondary sources, acknowledge them using an accepted referencing style

4. REPRESENTING

OUTCOMES

A student:

> represents qualitative and quantitative data and information using a range of appropriate media CH11-4

CONTENT

Students:

- represent qualitative and quantitative data and information using a range of formats, digital technologies and appropriate media (ACSBL004, ACSBL007)

5. ANALYSING

OUTCOMES

A student:

> analyses primary and secondary information sources CH11-5

CONTENT

Students:

- determine trends, patterns and relationships; identify error, uncertainty and limitations in data, including primary data and secondary-sourced information (ACSBL004, ACSBL005, ACSBL033)
- evaluate the relevance, accuracy, validity and reliability of primary and secondary-sourced data (ACSBL005)

6. SOLVING PROBLEMS

OUTCOMES

A student:

> solves scientific problems CH11-6

CONTENT

Students:

- use modelling (including mathematical examples) to explain phenomena, make predictions and/or solve problems using evidence from primary and/or secondary sources (ACSBL006, ACSBL010)

7. COMMUNICATION

OUTCOMES

A student:

> communicates scientific understanding CH11-7

CONTENT

Students:

- use suitable forms of digital, visual, written and verbal forms of communication
- apply appropriate scientific notations, nomenclature and scientific language to communicate in a variety of contexts (ACSBL008, ACSBL036)

UNIT 1 FUNDAMENTALS OF CHEMISTRY

MODULE 1 PROPERTIES AND STRUCTURE OF MATTER

OUTCOMES

A student:

> designs and plans appropriate scientific investigations CH11-2
> conducts primary or secondary-sourced investigations individually or in a team CH11-3
> represents qualitative and quantitative data and information using a range of appropriate media CH11-4
> communicates scientific understanding CH11-7
> explores the properties and trends in the physical, structural and chemical aspects of matter CH11-8

CONTENT FOCUS

In this module students analyse trends and patterns in relation to the properties of pure substances and use these to predict the properties of other pure substances. This knowledge is used to determine ways that substances can be separated from each other and ways that allow them to remain together.

Materials can be either pure substances with distinct measurable properties (for example, melting and boiling point, reactivity, strength, density) or mixtures with properties dependent on the identity and relative amounts of the substances that make up the mixture. The analysis of these properties has led to the expansion of the Periodic Table and the advancement of atomic theory and allowed for the development of complex models that has been subject to much peer-review and evidence, gathering across many disciplines over time.

Students will use knowledge obtained from the study of the Periodic Table to examine trends and patterns that exist between elements and atoms to discover that fundamental particles and their role in the structure of an atom gives all chemicals their properties.

Working Scientifically
Opportunities are provided for students to engage with all the Working Scientifically skills for each investigation. In this module teachers and students focus on designing and conducting investigations, obtaining and representing data in the most appropriate manner and to communicate ideas about the structural, physical and chemical aspects of matter.

CONTENT

Properties of matter

Inquiry question: How do the properties of substances help us to separate them?

Students:

- explore pure substances (elements and compounds), homogeneous mixtures and heterogeneous mixtures by:
  - separation techniques based on physical properties (ACSCH026)
  - calculating percentage composition of component elements and/or compounds (ACSCH007)
  - the application of chemical nomenclature of inorganic substances 

- classify the elements based upon their properties and position in the periodic table through their:
  - physical properties
  - chemical properties

Atomic structure and atomic mass

Inquiry question: What makes elements different from each other?

Students:
- investigate the components of atoms through:
  - relative charges and position in the periodic table
  - calculation of relative isotopic mass (ACSCH024)
  - representation of the symbol, atomic number and atomic mass (nucleon number)
  - a model of the atom's distinct energy levels including electronic configuration and spdf notation (ASCH017, ASCH018, ASCH020)
- investigate elements that possess the physical property of allotropy
- investigate electron transfer between atomic energy levels through:
  - collecting primary data from a flame test using metals in different ionic solutions (ACSCH019)
  - reviewing secondary-sourced information for the spectra of different metals

Periodicity

Inquiry question: Is there a pattern in the properties of elements?

Students:
- demonstrate, explain and predict the observable trends of elements in periods and groups in the periodic table through
  - gathering information through secondary information sources (ACSCH016, ACSCH017)
  - representing data in a variety of forms

Bonding

Inquiry question: What keeps chemicals together?

Students:
- investigate the differences between ionic and covalent compounds through:
  - nomenclature, valency and chemical formulae (including Lewis dot diagrams) (ACSCH029)
  - examining the differences between electronegativity of constituent elements
  - modelling the shapes of molecular substances (ACSCH056, ACSCH057)
- explore the similarities and differences between the nature of intermolecular and intramolecular bonds and the energies associated with each in order to explain:
  - physical properties of elements
  - physical properties of compounds
  - chemical properties of elements
  - chemical properties compounds (ACSCH020, ACSCH055, ACSCH058)

UNIT 1 FUNDAMENTALS OF CHEMISTRY

MODULE 2 INTRODUCTION TO QUANTITATIVE CHEMISTRY

OUTCOMES

A student:

> designs and plans appropriate scientific investigations CH11-2
> represents qualitative and quantitative data and information using a range of appropriate media CH11-4
> solves scientific problems CH11-6
> describe, apply and quantitatively analyse the mole concept and stoichiometric relationships CH11-9

CONTENT FOCUS

In this module students are introduced to the quantitative nature of Chemistry. Chemists must be able to quantify reactions in order to make predictions about yields and communicate to specific audiences for specific purposes using nomenclature, genres and modes unique to the discipline. Using the mole concept, students will have the opportunity to select and use appropriate mathematical representations to solve problems, make predictions and to calculate the mass of reactants and products, whether solid, liquid or gas.

Students will further develop their understanding of the universal language of Chemistry and are introduced to the idea that Science is a global enterprise that relies on clear communication, international conventions, peer review and reproducibility.

Working Scientifically
Opportunities are provided for students to engage with all the Working Scientifically skills for each investigation. In this module students focus on developing investigations that enable students to obtain quantitative data to assist in solving problems related to quantitative chemistry.

CONTENT

Chemical reactions and stoichiometry

Inquiry question: What happens in chemical reactions?

Students:

- conduct investigations to observe and measure the quantitative relationships of chemical reactions, including but not limited to:
  - masses of solids and/or liquids in chemical reactions
  - volumes of gases in chemical reactions (ACSCH046)
- relate stoichiometry to the Law of Conservation of Mass in chemical reactions by investigating:
  - balancing chemical equations (ACSCH039)
  - solving problems regarding mass changes in chemical reactions (ACSCH046)

The mole concept

Inquiry question: How do we measure in Chemistry?

Students:

- conduct an investigation to demonstrate and calculate the mass of one mole of substances in:
  - an element
  - a compound (ACSCH046)
- conduct an investigation to determine that chemicals react in simple whole number ratios
- explore the concept of the mole and relate this to Avogadro's number to describe, calculate and manipulate masses, moles and number of particles in: (ACSCH007, ACSCH039)
  - masses of elements and compounds $n = \frac{m}{MM}$ (n = number of moles, m = mass in grams, MM = molar mass in $gmol^{-1}$)
  - percentage weight calculations and empirical formulae
  - limiting reagent reactions

Concentration and molarity

Inquiry question: How do we measure chemicals in solutions?

Students:

- conduct investigations to calculate concentrations and investigate the different ways concentrations are measured (ACSCH046, ACSCH063)
- conduct an investigation to make a standard solution and perform a dilution
- manipulate variables and solve problems to calculate concentration, mass or volume using:
  - $c = \frac{n}{V}$ (ACSCH063)
  - dilutions $c_1V_1 = c_2V_2$ *(c= concentration, V= volume)*

Gas laws

Inquiry question: How do we measure the quantities of gases?

Students:

- conduct investigations and solve problems to analyse the quantitative relationships involving an ideal gas (ACSCH060) including:
  - Gay Lussac's Law
  - Boyle's Law
  - Charles' Law
  - Avogadro's Law
  - Ideal Gas Law

UNIT 2 CHEMICAL INTERACTIONS AND DRIVING FORCES

MODULE 3 REACTIVE CHEMISTRY

OUTCOMES

A student:

> designs and plans appropriate scientific investigations CH11-2
> conducts primary or secondary-sourced investigations individually or in a team CH11-3
> represents qualitative and quantitative data and information using a range of appropriate media CH11-4
> explores the many different types of chemical reactions, in particular the reactivity of metals, and the factors that affect the rate of chemical reactions CH11-10

CONTENT FOCUS

All chemical reactions involve the creation of new substances and associated energy transformations, commonly observable as changes in the temperature of the surroundings and/or the emission of light. These reactions are harnessed and controlled by chemists to produce substances that lead to the development of useful products.

Chemicals can react at many different speeds and in many different ways yet they basically involve the breaking and making of chemical bonds. Students will study how chemicals react, the changes in matter and energy that take place during these reactions and how these relate to the chemicals that are used in everyday life.

Working Scientifically
Opportunities are provided for students to engage with all the Working Scientifically skills for each investigation. In this module students focus on designing and conducting investigations to obtain and represent data in the most appropriate manner about chemical reactions.

CONTENT

Chemical reactions

Inquiry question: What are the products of a chemical reaction?

Students:

- investigate a variety of reactions to identify the indicators of a chemical change
- use modelling to demonstrate
  - the rearrangement of atoms to form new substances
  - the conservation of atoms in a chemical reaction (ACSCH042, ACSCH080)
- investigate the chemical processes that occur when Aboriginal and Torres Strait Islander peoples detoxified poisonous food items
- conduct investigations to predict and identify the products of a range of reactions, for example:
  - synthesis
  - decomposition
  - combustion
  - precipitation

  - acid base reactions
  - acid carbonate reactions (ACSCH042, ACSCH080)
- construct balanced equations to represent chemical reactions

Predicting reactions of metals

Inquiry question: Can we predict how metals vary in their reactivity?

Students:
- conduct investigations to compare the reactivity of a variety of metals in:
  - water
  - dilute acid (ACSCH032, ACSCH037)
  - construct a metal activity series from the data obtained from primary investigations and compare with standard secondary-sourced information (ACSCH103)
- explain patterns in metal activity on the periodic table, for example:
  - ionisation energy (ACSCH045)
  - atomic radius (ACSCH007)
  - electronegativity (ACSCH057)
- justify the uses of a range of metals based on their activity

Corrosion of metals

Inquiry question: Why do metals corrode?

Students:
- conduct investigations into the factors that affect corrosion
- conduct investigations to measure the potential of half cells
- predict the reaction of metals in solutions using the table of Standard Reduction Potentials
- construct relevant half equations and balanced overall equations to represent a range of oxidation and reduction (redox) reactions
- calculate the standard cell potential for selected redox reactions
- predict the spontaneity of redox reactions using the value of cell potentials (ACSCH079, ACSCH080)

Applications of redox reactions

Inquiry question: How is a knowledge of oxidation and reduction reactions used in modern society?

Students:
- construct labelled diagrams of galvanic cells identifying the main features
- conduct investigations to:
  - predict the effect of factors such as concentration of the electrolyte and temperature on cell potential
  - compare a range of galvanic cells (ACSCH079)
- investigate applying an external emf to reverse redox reactions and relate this to rechargeable cells
- conduct an investigation to observe applications of electrolysis, for example:
  - decomposition
  - electroplating
  - electroforming
  - electrolytic refining (ACSCH079, ACSCH080)

Rates of reactions

Inquiry question: What affects the rate of a chemical reaction?

Students:

- conduct an investigation to collect data, analyse and report on, using appropriate tools, including digital technologies, how the rate of a chemical reaction can be affected by a range of factors, including but not limited to:
  - temperature
  - surface area
  - concentration
  - catalysts (ACSCH042)
- investigate the role of activation energy, collisions and molecular orientation in collision theory
- explain a change in reaction rate using collision theory (ACSCH003, ACSCH046)

UNIT 2 CHEMICAL INTERACTIONS AND DRIVING FORCES

MODULE 4 DRIVERS OF REACTIONS

OUTCOMES

A student:

> poses questions and hypotheses for scientific investigation CH11-1
> analyses primary and secondary information sources CH11-5
> solves scientific problems CH11-6
> communicates scientific understanding CH11-7
> analyses the energy considerations in the driving force for chemical reactions CH11-11

CONTENT FOCUS

In this module, students investigate factors that initiate and drive a reaction. They examine the relationship between enthalpy and entropy to calculate the Gibbs free energy and the role each plays in the spontaneity of reactions. Students will understand that all chemical reactions involve the creation of new substances and associated energy transformations commonly observable as changes in temperature of the surrounding environment and/or emission of light.

Students will conduct investigations to measure the heat energy changes that occur in chemical reactions and describe reactions using terms such as endothermic and exothermic. They will explain reactions in terms of the Law of Conservation of Energy and use Hess's Law to calculate enthalpy changes involved in the breaking and making of bonds.

Working Scientifically
Opportunities are provided for students to engage with all the Working Scientifically skills for each investigation. In this module students focus on developing questions and hypotheses, analyse trends, patterns and relationships in data in order to solve problems and communicate ideas about the driving forces in chemical reactions.

CONTENT

Energy changes in chemical reactions

Inquiry question: What energy changes occur in reactions?

Students:

- conduct investigations to measure temperature changes in examples of exothermic and endothermic reactions including:
  - combustion
  - dissolution (ACSCH018, ACSCH037)
- construct balanced chemical equations to represent complete and incomplete combustion reactions
- investigate enthalpy changes in reactions using $\Delta H = mc\Delta T$ to calculate, analyse and compare experimental results to validate secondary-sourced data
- construct energy profile diagrams to represent and analyse the enthalpy changes and activation energy associated with a chemical reaction (ACSCH072)
- model and analyse the role of catalysts in reactions (ACSCH073)

Enthalpy and Hess's Law

Inquiry question: How much energy does it take to break bonds and how much is released?

Students:

- explain the enthalpy changes in a reaction in terms of breaking and reforming bonds and relate this to:
  - the Law of Conservation of Energy
  - the standard heat of formation of compounds (ACSCH037)
- conduct investigations demonstrating Hess's Law and calorimetry to quantify enthalpy changes in reactions
- apply Hess's Law to simple energy cycles and solve problems to quantify enthalpy changes including but not limited to:
  - heat of combustion
  - enthalpy involved in photosynthesis
  - enthalpy involved in respiration (ACSCH037)

Entropy

Inquiry question: Do all reactions increase the disorder and chaos of the arrangement of atoms?

Students:

- use modelling to illustrate entropy changes in reactions
- predict entropy changes from balanced chemical reactions to classify as increasing or decreasing entropy
- solve problems to calculate entropy changes, ΔS^o, for reactions

Gibbs free energy

Inquiry question: Why do some reactions occur spontaneously?

Students:

- analyse the relationship between entropy and enthalpy
- explain reaction spontaneity using terminology including: (ACSCH072)
  - Gibbs free energy
  - enthalpy
  - entropy
- solve problems using $\Delta G = \Delta H - T\Delta S$ to classify reactions as spontaneous or nonspontaneous
- predict the effect of temperature changes on spontaneity (ACSCH070)

YEAR 11 DEPTH STUDY

OUTCOMES

Skills

A student:

> poses questions and hypotheses for scientific investigation CH11-1
> designs and plans appropriate scientific investigations CH11-2
> conducts primary or secondary-sourced investigations individually or in a team CH11-3
> represents qualitative and quantitative data and information using a range of appropriate media CH11-4
> analyses primary and secondary information sources CH11-5
> solves scientific problems CH11-6
> communicates scientific understanding CH11-7

Knowledge and understanding

A student:

> explores the properties and trends in the physical, structural and chemical aspects of matter CH11-8
> describes, applies and quantitatively analyses the mole concept and stoichiometric relationships CH11-9
> explores the many different types of chemical reactions, in particular the reactivity of metals, and the factors that affect the rate of chemical reactions CH11-10
> analyses the energy considerations in the driving force for chemical reactions CH11-11

CONTENT

Possible Depth studies

Unit 1 Fundamentals of Chemistry

- How are chemical calculations used to predict products in industrial processes?
- How has technology changed our understanding of the mole?
- How does a 'real' gas vary from the 'ideal'?
- Investigate an industry in the local community (eg mine) and see how chemical relationships and calculations are integral to it.
- Investigate secondary-sourced information to evaluate the scientists who contributed to our understanding of the mole concept.

Unit 2 Chemical Interactions and Driving Forces

- How does alloying change a metal's activity and what are the uses of alloys?
- How is a knowledge of redox reactions used in the mining and refining of metals?
- Investigate how a fuel cell works and evaluate the uses of fuel cells.
- What are some industrial or biological uses of catalysts?
- Investigate the many fuels used in our world.
- Research fuels, including fossil fuels and biofuels, can be compared in terms of their energy output, suitability for purpose, and the nature of products of combustion. (ACSCH038)
- Investigate the role of Catalysts in industrial processes.
- Investigate the ethical harvesting and extraction of Aboriginal and Torres Strait Islander traditional medicines.

CHEMISTRY YEAR 12 COURSE CONTENT

WORKING SCIENTIFICALLY SKILLS

The following Working Scientifically outcomes and content are to be integrated into each module wherever students undertake an investigation.

1. QUESTIONING

OUTCOMES

A student:

> develops and evaluates questions and hypotheses for scientific investigation CH12-1

CONTENT

Students:

- develop and evaluate inquiry questions and hypotheses to identify an area that can be investigated scientifically, involving primary and/or secondary-sourced data (ACSBL001)

2. DESIGNING INVESTIGATIONS

OUTCOMES

A student:

> designs, plans and evaluates primary and secondary-sourced investigations CH12-2

CONTENT

Students:

- assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning an investigation (ACSBL031)
- justify and evaluate the use of variables and experimental controls to ensure that a valid procedure is developed that allows for the reliable collection of data (ACSBL002)

3. CONDUCTING INVESTIGATIONS

OUTCOMES

A student:

> conducts primary and secondary-sourced investigations individually or in a team CH12-3

CONTENT

Students:

- employ and evaluate safe work practices and manage risks (ACSBL031)
- use appropriate technologies, evaluate accuracy and identify sources of error
- select and extract information from a wide range of reliable secondary sources and acknowledging them using an accepted referencing style

4. REPRESENTING

OUTCOMES

A student:

> selects and represents key qualitative and quantitative data and information using a range of appropriate media CH12-4

CONTENT

Students:

- select and represent qualitative and quantitative data and information and represent them using a range of formats, digital technologies and appropriate media (ACSBL004, ACSBL007)

5. ANALYSING

OUTCOMES

A student:

> analyses primary and secondary information sources CH12-5

CONTENT

Students:

- derive trends, patterns and relationships; consider error, uncertainty and limitations in data; and interpret scientific and media texts (ACSBL004, ACSBL005, ACSBL033)
- evaluate the relevance, accuracy, validity and reliability of primary and secondary-sourced data and suggest improvements to investigations (ACSBL005)

6. SOLVING PROBLEMS

OUTCOMES

A student:

> solves scientific problems using primary and secondary data CH12-6

CONTENT

Students:

- use modelling (including mathematical examples) to explain phenomena, make predictions and solve problems using evidence from primary and secondary sources (ACSBL006, ACSBL010)

7. COMMUNICATION

OUTCOMES

A student:

> communicates scientific understanding using suitable language and terminology CH12-7

CONTENT

Students:

- select and use suitable forms of digital, visual, written and verbal forms of communication
- select and apply appropriate scientific notations, nomenclature and scientific language to communicate in a variety of contexts (ACSBL008, ACSBL036)
- construct evidence based arguments and engage in peer feedback to evaluate an argument and assess its validity (ACSBL034, ACSBL036)

UNIT 3 EQUILIBRIUM AND ACIDS

MODULE 5 EQUILIBRIUM REACTIONS

OUTCOMES

A student:

> selects and represents key qualitative and quantitative data and information using a range of appropriate media CH12-4
> analyses primary and secondary information sources CH12-5
> solves scientific problems using primary and secondary data CH12-6
> communicates scientific understanding using suitable language and terminology CH12-7
> explains the characteristics of equilibrium systems, and the factors that affect these systems CH12-8

CONTENT FOCUS

Chemical systems may be open or closed and include physical changes and chemical reactions which can result in observable changes to a system. In this module, students study the effects of changes in temperature, concentration of chemicals and pressure on equilibrium systems and that these can be predicted by applying Le Chatelier's Principle. Students will also analyse the quantitative relationship between products and reactants in equilibrium reactions to determine an equilibrium constant, and from this calculation, students will then predict the equilibrium position, either favouring the formation of products or reactants in a chemical reaction.

This module also allows students to understand that scientific knowledge enables scientists to offer valid explanations and make reliable predictions. Students will make such predictions by comparing equilibrium calculations and equilibrium constants to determine whether a combination of two solutions will result in the formation of a precipitate.

Working Scientifically

Opportunities are provided for students to engage with all the Working Scientifically skills for each investigation. In this module students focus on collecting and representing data to determine patterns and trends that enable the student to solve problems and communicate ideas about equilibrium reactions.

CONTENT

Static and dynamic equilibrium

Inquiry question: What happens when chemical reactions don't go to completion?

Students:

- conduct investigations to analyse the reversibility of chemical reactions, for example:
  - cobalt chloride hydrated and dehydrated
  - Iron (III) nitrate and potassium thiocyanate
  - burning magnesium
  - burning steel wool (ACSCH090)
- model static and dynamic equilibrium to analyse the differences in open and closed systems (ACSCH079, ACSCH091)

- analyse examples of non-equilibrium systems in terms of the effect of entropy and enthalpy, for example:
  - combustion reactions
  - solubility reactions
- investigate the relationship between collision theory and reaction rate to analyse chemical equilibrium reactions. (ACSCH070, ACSCH094)

Factors that affect equilibrium

Inquiry question: What factors affect equilibrium and how?

Students:
- investigate the effects of temperature, concentration, volume and/or pressure on a system at equilibrium and relate the effects to Le Chatelier's principle, for example:
  - heating cobalt chloride hydrate
  - interaction between nitrogen dioxide and dinitrogen tetroxide
  - iron (III) thiocyanate and varying concentration of ions (ACSCH095)
- apply Le Chatelier's Principle to explain the relationship between collision theory, reaction rate, activation energy and chemical equilibrium (ACSCH094)

Calculating the equilibrium constant

Inquiry question: How can the position of equilibrium be represented and what does the equilibrium constant represent?

Students:
- deduce the equilibrium expression *(K_{eq})* for homogeneous reactions occurring in solution and as gases (ACSCH079, ACSCH096)
- perform calculations to evaluate the changes in the value of K_{eq} and in concentrations of substances within an equilibrium system and use these values to make predictions on the direction in which a reaction may proceed (ACSCH096)
- analyse the effect of temperature on the value of K_{eq} (ACSCH093)
- conduct an investigation to determine K_c of a chemical equilibrium system, for example:
  - esterification of an alkanol and an alkanoic acid (ACSCH096)
- explore the use of K_{eq} for different types of chemical reactions, including but not limited to:
  - dissociation of ionic solutions
  - dissociation of acids and bases (ACSCH098, ACSCH099)

Solution equilibria

Inquiry question: How does solubility relate to chemical equilibrium?

Students:
- describe and evaluate the processes involved in the dissolution of ionic compounds in water
- investigate the processes used by Aboriginal and Torres Strait Islander peoples when removing toxicity from foods, for example:
  - toxins in cycad fruit
- conduct an investigation to determine solubility rules and predict and analyse the composition of substances when two ionic solutions are mixed, for example:
  - potassium chloride and silver nitrate
  - potassium iodide and lead nitrate
  - sodium sulphate and barium nitrate (ACSCH065)

- derive equilibrium expressions for saturated solutions K_{sp} and calculate the solubility of an ionic substance
- predict the formation of a precipitate given the standard reference values for K_{sp}
- conduct an investigation to determine the concentration of a specific ion, for example:
  – chloride ion concentration by titration against a known concentration of silver ions
- determine the maximum concentration of one ion before the addition of a third ion causes precipitation

UNIT 3 EQUILIBRIUM AND ACIDS

MODULE 6 ACID/BASE REACTIONS

OUTCOMES

A student:

> develops and evaluates questions and hypotheses for scientific investigation CH12-1
> designs, plans and evaluates primary and secondary-sourced investigations CH12-2
> conducts primary and secondary-sourced investigations individually or in a team CH12-3
> analyses primary and secondary information sources CH12-5
> describes, explains and quantitatively analyses acids and bases using contemporary models CH12-9

CONTENT FOCUS

In this module students analyse how and why the definition of an acid and a base has changed over time and how the current definition characterises the many chemical reactions of acids. Acids react in particular ways with a variety of substances and these follow a pattern that the students identify and explore in detail.

Acids and bases, and their reactions, are used extensively in everyday life and in the human body. The chemistry of acids and bases contributes to industrial contexts and the environment and is it essential that the degree of acidity in these situations is continually monitored. By investigating the qualitative and quantitative properties of acids and bases, students learn to appreciate the importance of pH and indicators.

Working Scientifically
Opportunities are provided for students to engage with all the Working Scientifically skills for each investigation. In this module students focus on developing questions and test hypotheses through designing and conducting investigations and analysis of data from acid/base reactions.

CONTENT

Neutralisation

Inquiry question: What is an acid and what is a base?

Students:

- conduct an investigation to demonstrate the nomenclature and the properties of common acids and bases (ACSCH067)
- conduct an investigation to demonstrate the preparation and use of indicators as illustrators of the characteristics and properties of acids, bases and their reversible reactions (ACSCH101)
- predict the outcomes of reactions of acids and write balanced equations to represent the following:
  - acids and bases
  - acids and carbonates
  - acids and metals (ACSCH067)
- investigate applications of neutralisation reactions in everyday life and industrial processes
- conduct an investigation to measure the enthalpy of neutralisation (ACSCH093)

- explore the changes in definitions and models of an acid and a base over time to explain the limitations of each model:
  - Arrhenius' Theory
  - Brønsted–Lowry Theory
  - Lewis Theory (ACSCH064, ACSCH067)

Using Arrhenius' Theory

Inquiry question: What is the role of water in acids and bases?

Students:
- conduct an investigation to measure the pH of a range of acids and bases
- calculate pH, pOH, hydrogen ion concentration ($[H^+]$) and hydroxide ion concentration ($[OH^-]$) for a range of solutions (ACSCH102)
- conduct an investigation to demonstrate the use of pH to indicate the differences between the strength of acids and bases (ACSCH102)
- write ionic equations to represent the dissociation of acids and bases in water, the conjugate acid/base pairs in solution and the amphiprotic nature of some salts, for example:
  - sodium hydrogen carbonate
  - ammonium chloride
- construct models and/or animations to communicate the differences between strong, weak, concentrated and dilute, acids and bases (ACSCH099)
- calculate the pH of the resultant solution when solutions of acids and/or bases are diluted or mixed

Quantitative analysis

Inquiry question: How can we analyse solutions of acids and bases?

Students:
- conduct valid and reliable investigations to analyse the concentration of an unknown acid or base by titration
- investigate titration curves and conductivity graphs to analyse data to indicate characteristic reaction profiles, for example:
  - strong acid/strong base
  - strong acid/weak base
  - weak acid/strong base (ACSCH080, ACSCH102)
- model neutralisation of strong and weak acids and bases using a variety of media
- calculate and apply the dissociation constant, K_a and pK_a for strong and weak acids (ACSCH098)
- explore acid/base analysis techniques applied:
  - in industries
  - by Aboriginal and Torres Strait Islander peoples
  - using digital probes and instruments
- conduct a chemical analysis of a common substance, such as soft drink, wine, juice, or a medicine for its acidity or basicity (ACSCH080)
- conduct an investigation to prepare a buffer and demonstrate the properties of a buffer (ACSCH080)
- describe the importance of buffers in natural systems (ACSCH098, ACSCH102)

UNIT 4 APPLICATIONS OF CHEMISTRY

MODULE 7 ORGANIC CHEMISTRY

OUTCOMES

A student:

> analyses primary and secondary information sources CH12-5
> solves scientific problems using primary and secondary data CH12-6
> communicates scientific understanding using suitable language and terminology CH12-7
> analyses the structure and predicts reactions involving carbon compounds CH12-10

CONTENT FOCUS

In this module, students focus on the principles and applications of chemical synthesis in the field of organic chemistry. Current and future applications of chemistry include techniques to synthesise new substances to meet the needs of society, including pharmaceuticals, fuels and polymers.

Each class of organic compounds displays characteristic chemical properties and undergoes specific reactions based on the functional groups present. These reactions, including acid-base and oxidation reactions, are used to identify the class of an organic compound. In this module, students investigate the many classes of organic compounds and their characteristic chemical reactions. By considering the primary, secondary and tertiary structures of organic materials, students gain an understanding of the properties of materials including strength, density and biodegradability and relate these to proteins, carbohydrates and synthetic polymers.

Working Scientifically

Opportunities are provided for students to engage with all the Working Scientifically skills for each investigation. In this module students focus on collecting and analysing data and information to identify trends, patterns and relationships to solve problems and communicate ideas about organic chemistry.

CONTENT

Hydrocarbons

Inquiry question: How can carbon form different types of hydrocarbons?

Students:

- construct models, identify the functional group and write structural and molecular formulae for homologous series, up to C8:
  - alkanes
  - alkenes
  - alkynes (ACSCH035)
- investigate the nomenclature of hydrocarbons, up to C8, using IUPAC conventions, including simple methyl and ethyl branched chains (ACSCH127)
- explore and distinguish the different types of structural isomers, including saturated and unsaturated hydrocarbons (ACSCH035)
- conduct an investigation to compare the properties within a homologous series, and explain these differences in terms of bonding (ACSCH035)

- investigate the hybridisation of carbon and the $\sigma(sigma)$and $\pi(pi)$ bonds associated with single, double and triple bonds between carbon atoms
- investigate the source, production and uses of a range of hydrocarbons
- describe the procedures required to safely handle and dispose of organic substances (ACSCH075)

Alcohols and carboxylic acids

Inquiry question: What other functional groups exist and how do they react?

Students:

- construct models, identify functional groups and write and name structural and molecular formulae using IUPAC nomenclature and conventions for up to C8:
  - alcohols (primary, secondary and tertiary)
  - carboxylic acids
- conduct an investigation to explain the properties within and between the homologous series of alkanes, alcohols and carboxylic acids, with reference to the intermolecular and intramolecular bonding present
- conduct an investigation to measure and compare reliably the enthalpy of combustion for a range of alcohols
- conduct an investigation to prepare ethanol by fermentation
- compare and contrast the fuels from inorganic sources to biofuels

The products of reactions involving hydrocarbons

Inquiry question: What uses are there for products of reactions involving hydrocarbons?

Students:

- conduct an investigation to compare the products of complete and incomplete combustion of hydrocarbons
- investigate, write equations and construct models to represent the addition reactions of unsaturated hydrocarbons with:
  - hydrogen, H_2
  - halogens, X_2
  - hydrogen halides, HX
  - water, H_2O (ACSCH136)
- investigate, write equations and construct models to represent the substitution reactions (with halogens) of saturated hydrocarbons
- conduct an investigation to distinguish between saturated and unsaturated hydrocarbons
- conduct investigations to model and compare the structure, properties and uses of addition polymers of ethene, for example:
  - polyethylene PE
  - polyvinyl chloride PVC
  - polystyrene PS
  - polytetrafluoroethylene PTFE (ACSCH136)
- describe the formation of condensation polymers, for example:
  - nylon
- evaluate the current production of polymers formed from inorganic sources to those formed from organic sources (ACSCH128)

Reactions of alcohols and carboxylic acids

Inquiry question: What products are formed from the reactions of alkanols and/or alkanoic acids?

Students:

- investigate the name, structural formulae, properties and functional group for:
  - primary, secondary and tertiary alcohols
  - aldehydes and ketones (ACSCH127)
- write equations, stating conditions and predicting products to represent the reactions of alcohols including but not limited to:
  - combustion
  - dehydration
  - substitution with HX
  - oxidation
  - esterification (ACSCH128, ACSCH136)
- conduct an investigation to distinguish between primary, secondary and tertiary alcohols
- investigate the production, in a school laboratory, of simple esters
- investigate the uses of simple esters
- investigate the structure and action of soaps and detergents
- conduct an investigation to prepare a soap
- investigate industrial uses of aldehydes and/or ketones (ACSCH127)
- draft and construct flowcharts to show reaction pathways for chemical synthesis, including those that involve more than one step
- investigate the conditions required for the industrial production of a polyester (ACSCH136)

Carbohydrates

Inquiry question: What is the structure and function of carbohydrates?

Students:

- use modelling to investigate the structure of carbohydrates, for example:
  - monosaccharides
  - starch
  - cellulose (ACSCH129)
- conduct investigations to carry out distinguishing tests for a range of carbohydrates, for example:
  - starch
  - reducing and non-reducing sugars (ACSCH129)

UNIT 4 APPLICATIONS OF CHEMISTRY

MODULE 8 APPLYING CHEMICAL IDEAS

OUTCOMES

A student:

> develops and evaluates questions and hypotheses for scientific investigation CH12-1
> designs, plans and evaluates primary and secondary-sourced investigations CH12-2
> conducts primary and secondary-sourced investigations individually or in a team CH12-3
> selects and represents key qualitative and quantitative data and information using a range of appropriate media CH12-4
> communicates scientific understanding using suitable language and terminology CH12-7
> describes and evaluates chemical systems used to design and analyse chemical processes CH12-11

CONTENT FOCUS

Chemistry is vital to all biological processes. Students will investigate a range of these processes and appreciate the intricate and vast range of chemical processes in nature.

In this module, students will also investigate and examine the applications of chemistry and that advances in science in one field can influence other areas of science, technology and engineering. They also examine how a knowledge of chemistry can be used to develop and evaluate projected economic, social and environmental impacts and with regard to these, design actions for sustainability. Students will be required to communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports where appropriate.

Working Scientifically
Opportunities are provided for students to engage with all the Working Scientifically skills for each investigation. In this module students focus on developing and evaluating questions and hypotheses when designing and conducting investigations, analyse trends, patterns and relationships in data and communicate about applying chemical ideas.

CONTENT

Environmental monitoring

Inquiry question: How do we monitor our environment?

Students:

- analyse the need for monitoring our environment
- conduct investigations, using a range of quantitative and qualitative techniques, to monitor the environment, for example:
  - water testing
  - soil testing
- investigate, using secondary sources, the remote monitoring that occurs in the environment, for example:
  - air pollution monitoring
  - atmospheric monitoring

- conduct investigations on a local ecosystem to investigate key areas that could be monitored
- conduct an investigation to examine the types of chemical methods that could be used for monitoring pollution and human impacts, for example:
  - dissolved oxygen content
  - biological oxygen demand
  - heavy metals
- conduct an investigation to compare Aboriginal and Torres Strait Islander peoples' traditional methods with contemporary methods of monitoring the environment

Analytical techniques

Inquiry question: How do we analyse substances?

Students:

- conduct investigations, both qualitative and quantitative, to analyse substances using variable techniques, including but not limited to:
  - flame tests
  - precipitation reactions
  - gravimetric analysis
  - back titrations (ACSCH064, ACSCH066, ACSCH080)
- investigate where these techniques are currently used
- predict, using evidence, the likelihood of these techniques being used in the future
- investigate, using secondary sources, a modern technological chemical technique used for analysis for inorganic or organic compounds

Chemistry of biological processes

Inquiry question: What role does chemistry play in our understanding of living things?

Students:

- use modelling to investigate the structure of enzymes and the factors affecting their function
- investigate the role of enzymes as catalysts in the human body
- research applications of food chemistry by investigating the structure of natural and artificial sweeteners and glycaemic index of foods

Materials

Inquiry question: What materials do we currently use and what may we use in the future?

Students:

- conduct investigations into the importance of catalysts and the role of chemists in this field
- investigate materials that have been and continue to be used by Aboriginal and Torres Strait Islander peoples, for example:
  - pigments and minerals
  - traditional medicines
  - food products
- investigate the developments of contemporary materials, including but not limited to:
  - carbon-based compounds
  - nanoparticles
- investigate the future of energy production, for example:
  - fuel cells

YEAR 12 DEPTH STUDIES

OUTCOMES

Skills
A student:

> develops and evaluates questions and hypotheses for scientific investigation CH12-1
> designs, plans and evaluates primary and secondary-sourced investigations CH12-2
> conducts primary and secondary-sourced investigations individually or in a team CH12-3
> selects and represents key qualitative and quantitative data and information using a range of appropriate media CH12-4
> analyses primary and secondary information sources CH12-5
> solves scientific problems using primary and secondary data CH12-6
> communicates scientific understanding using suitable language and terminology CH12-7

Knowledge and understanding
A student:

> explains the characteristics of equilibrium systems, and the factors that affect these systems CH12-8
> describes, explains and quantitatively analyses acids and bases using contemporary models CH12-9
> analyses the structure and predicts reactions involving carbon compounds CH12-10
> describes and evaluates chemical systems used to design and analyse chemical processes CH12-11

CONTENT

Possible depth studies

Unit 3 Equilibrium and Acids

- Investigate the Haber Process.
- How can the equilibrium constant be utilised in industrial processes?
- Discuss the limitations of Brønsted-Lowry Theory of acids and bases.
- How do the acid-base properties of oxides of elements change across a period of the Periodic Table?
- Examine how Aboriginal and Torres Strait Islander peoples extracted useful chemicals from local plants.
- Explain the changes in pH of a solution containing dissolved carbon dioxide.
- Investigate the identity, source and effects of acidic oxides present in the atmosphere and discuss the importance of monitoring the atmospheric composition.

Unit 4 Applications of Chemistry

- Investigate the production of diesel fuel from waste cooking oil.
- Investigate analytical techniques used to determine the structure of organic chemicals.
- Design and carry out a product synthesis to maximise the yield or purity of a product and calculate the percentage yield of product.
- Investigate the structure, use and benefits of an organic substance such as aspirin, ibuprofen, paracetamol, saccharin, insulin or casein.
- Investigate the structure and chemistry of an alcohol breathalyser.
- Investigate fuel cells and the use metal nanoparticles as catalysts to improve the efficiency of energy production. (ACSCH109)
- Investigate the effectiveness of the chemicals used in chemotherapy.
- Conduct a field study to monitor an ecosystem in the local environment.

GLOSSARY

 for your information

The glossary explains terms that will assist teachers in the interpretation of the subject. The glossary will be based on the NSW Science K–10 glossary and the Australian curriculum senior secondary years Chemistry glossary.

 consult

Glossary term	Definition
account	Account for: State reasons for, report on. Give an account of: narrate a series of event or transactions.
analyse	To consider in detail for the purpose of finding meaning or relationships, and identifying patterns, similarities and differences.
apply	Use, utilise, employ in a particular situation.
assess	Make a judgement of value, quality, outcomes, results or size.
calculate	Ascertain/determine from given facts, figures or information.
clarify	Make a clear plain.
classify	Arrange or include in classes/categories.
compare	Show how things are similar or different.
conclusion	A judgement based on evidence.
construct	Make, build, put together items or arguments.
contrast	Show similarities or differences
controlled variable	A variable that is kept constant (or changed in constant ways) during an investigation.
Country	An area that is traditionally owned and looked after by an Aboriginal language group or community or certain people within that group. The term may indicate more than simply a geographical area; it is also a concept that can encompass the spiritual meanings and feelings of attachment associated with that area
critically (analyse/evaluate)	Add a degree of accuracy or depth, knowledge and understanding, logic, questioning, reflection and quality to (analyse/evaluate)
deduce	Draw conclusions

Glossary term	Definition
define	State meaning and identify essential qualities
demonstrate	Show by example
dependent variable	A variable that changes in response to changes to the independent variable in an investigation.
design	To plan and evaluate the construction of a product or process, including an investigation.
digital technologies	Systems that handle digital data, including hardware and software, for specific purposes.
discuss	Identify issues and provide points for and against.
distinguish	Recognise or note/indicate as being distinct or different from; to note differences between.
enthalpy	A thermodynamic quantity equivalent to the total heat content of a system.
entropy	The degree of disorder or randomness in the system.
environment	All the surroundings, both living and non-living.
evaluate	To examine and judge the merit or significance of something, including processes, events, descriptions, relationships or data.
examine	Inquire into.
explain	Relate cause and effect; make the relationship between things evident/provide why and/or how.
extract	Choose relevant and/or appropriate.
extrapolate	Extend the application of (a method or conclusion, especially one based on statistics) to an unknown situation by assuming that existing trends will continue or similar methods will be applicable.
hypothesis	A tentative idea or explanation for an observation, which can be tested and either supported or refuted by investigation.
identify	Recognise and name.
independent variable	A variable that is changed in an investigation to see what effect it has on the dependent variable.
inquiry question	A driving question for an investigation
interpret	Draw meaning from.
investigate	Conduct an investigation.

Glossary term	Definition
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.
justify	Support an argument or conclusion
model	A representation that describes, simplifies, clarifies or provides an explanation of the workings, structure or relationships within an object, system or idea.
outline	Sketch in general terms; indicate the main features.
Place	A space mapped out by physical or intangible boundaries that individuals or groups of Torres Strait Islander peoples occupy and regard as their own. It is a space with varying degrees of spirituality.
plan	Decide on and make arrangements for in advance.
predict	Suggest what might happen based on available information
primary sources	Information created by a person or persons directly involved in a study or observing an event.
propose	Put forward (for example a point of view, idea, argument, suggestion) for consideration or action.
qualitative	Relating to, measuring, or measured by the quality of something.
quantitative	Relating to, measuring, or measured by the quantity of something.
recall	Present remembered ideas, facts or experiences.
recommend	Provide reasons in favour.
recount	Retell a series of events.
relate	To identify connections or associations between ideas or relationships or between components of systems and structures.
reliability	Data that have 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.
secondary-sourced investigation	Information that has been compiled from primary sources by a person or persons not directly involved in the original study or event.
summarise	Express, concisely, the relevant details.

Glossary term	Definition
synthesise	Putting together various elements to make a whole.
theory	An explanation of a set of observations that is based on one or more proven hypotheses, which has been accepted through consensus by a group of scientists.
validity	An extent to which tests measure what was intended; an extent to which data, inferences and actions produced from tests and other processes are accurate.
variable	A factor that can be changed, kept the same or measured in an investigation, for example, time, distance, light, temperature.