BOSTES | BOARD OF STUDIES TEACHING & EDUCATIONAL STANDARDS NSW

Chemistry
Senior Years

Writing Brief

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Contents

1. Introduction

In 2014, the Board of Studies, Teaching and Educational Standards NSW (BOSTES) commenced a review of NSW senior secondary syllabuses for English, Mathematics, Science and History learning areas to determine directions for the incorporation of the senior secondary Australian curriculum. BOSTES conducted consultation in August and September 2014 on proposed directions outlined in *NSW Senior Secondary Review & Evaluation: English, Mathematics, Science and History*.

The broad directions for each learning area, developed following consultation, were endorsed by BOSTES in December 2014 and are available in Appendix I of this writing brief.

The development of the *Chemistry Senior Years Writing Brief* takes account of the broad directions and feedback gathered through consultation conducted in October and November 2015.

The purpose of the writing brief is to inform the directions for draft syllabus development. The writing brief is structured according to the elements of a Stage 6 syllabus. Each element includes proposed actions and key considerations for writers. These elements are:

- Rationale
- The place of the Chemistry Senior Years syllabus in the K–12 curriculum
- Aim
- Objectives
- Outcomes
- Course structure
- Content, including how Australian curriculum content may be incorporated
- Glossary.

The draft syllabus package will include the elements of a syllabus and Australian curriculum content identified with codes, learning across the curriculum content identified by icons, further information about meeting the diversity of learners, and internal and external assessment.

The draft syllabus for Chemistry will be developed and available for consultation during 2016.

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

Diversity of learners

NSW senior secondary syllabuses will be inclusive of the learning needs of all students. The draft syllabuses will be designed to accommodate teaching approaches that support student diversity under the sections ‘Students with special education

needs', 'Gifted and talented students' and 'Students learning English as an additional language or dialect (EAL/D)'.

For example:

Special education needs

All students with special education needs are entitled to participate in and progress through the curriculum. Some students may require additional support or adjustments to teaching, learning and assessment activities. 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.

Most students with special education needs will undertake regular Board Developed courses and/or Board Endorsed courses. Students with special education needs can access Years 11 and 12 outcomes and content in a range of ways. They should choose the most appropriate courses for the HSC in keeping with their goals, interests and learning needs.

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.

For some students with special education needs, the Years 11–12 Life Skills outcomes and content provided in the Senior Science Senior Years draft syllabus may provide learning more appropriate to their individual needs.

Australian curriculum

BOSTES began its syllabus development process for Stage 6 English, Mathematics, Science and History in 2014. This follows state and territory Education Ministers' endorsement of senior secondary Australian curriculum in these learning areas as the agreed and common base for development of state and territory senior secondary courses. It was also agreed that states and territories would have the flexibility to integrate the approved senior secondary Australian curriculum as appropriate. The writing brief determines how Australian curriculum content can be modified, reordered and supplemented in each learning area, while remaining compatible with the NSW Senior Years assessment and examinations structures.

2. Chemistry key

ⓘ for your information

The following codes will be used in the Chemistry Senior Years draft syllabus.

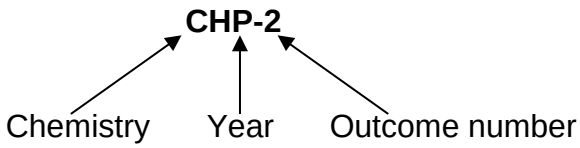
Outcome coding

Syllabus outcomes will be coded in a consistent way. The code identifies the subject, Year and outcome number.

Years of learning will be represented by the following codes:

Year	Code
Year 11	P
Year 12	H

In the Chemistry syllabus, outcome codes indicate the subject, Year and outcome number. For example:



Coding of the Australian curriculum content

Australian curriculum content descriptions included in the syllabus will be identified.

Actions for writers and key considerations

- Identify the Australian curriculum content descriptions by the Australian curriculum code.
- The code should appear in brackets at the end of each relevant content description.

3. 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 Senior Years curriculum
- how it prepares students for post-school pathways.

Proposed rationale for Chemistry Senior Years

Students of Senior Years Chemistry will learn that, as chemists, they will develop and utilise a range of skills including the ability to communicate succinctly and concisely, to think logically, to make evidence-based judgements and to think creatively and imaginatively. This subject will also provide a foundation for students to critically consider information and to make informed decisions about contemporary chemical issues in their everyday lives.

The course is designed for students who have substantial achievement in Stage 5 Science, including those who wish to continue with the study of science and specifically chemistry at tertiary level.

Our scientific knowledge and understanding and methods of working scientifically have led chemists to gain a better understanding of how substances interact in the real world. By working scientifically students design and conduct qualitative and quantitative investigations both individually and collaboratively. They investigate questions and hypotheses, manipulate variables, analyse data, evaluate claims, solve problems, and develop and communicate evidence-based arguments and models.

Thinking in Chemistry involves using differing scales including macro-, micro- and nano-scales; using specialised representations such as chemical symbols and equations; and being creative, as when designing new materials or models of chemical systems. The study of chemistry provides a foundation for undertaking investigations in a wide range of scientific fields and often provides the unifying link across interdisciplinary studies.

The application of chemical knowledge will be required to tackle major global issues and challenges now and into the future. These include issues of sustainability, supply of clean drinking water, efficient production and use of energy, management of mineral resources, increasing acidification of the oceans, and climate change.

Actions for writers and key considerations

- The rationale requires some revision to provide clarity and consistency of purpose with regard to the principles of chemistry, and to complement and better reflect the specific nature and characteristics of Chemistry.
- Where appropriate, the rationale should complement the aims and objectives of the syllabus.
- The use of terms such as ‘nano-scales’ and ‘contemporary’ should be reviewed in relation to their appropriateness or need.

4. The place of the Chemistry Senior Years syllabus in the K–12 curriculum

ⓘ for your information

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

This diagram will be included in the draft syllabus.

5. Aim

ⓘ for your information

In NSW syllabuses, the aim provides a statement(s) 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.

Proposed aim for Chemistry Senior Years

The aim of the Chemistry Senior Years syllabus is to develop students':

- appreciation of chemistry as an experimental science where models and theories are refined and new models and theories are developed through independent and collaborative research that has significant impacts on society
- abilities to debate and critically evaluate scientific arguments and claims, communicate to a range of audiences chemical understanding or findings and propose possible solutions
- understanding of the theories and models used to describe, explain and make predictions about chemical systems, structures and properties by considering the factors that affect these and how they can be controlled to produce desired products or outcomes
- respect for the environment through an understanding of how chemistry and chemical practices have developed, interact and are integral to the developments in the other sciences.

Actions for writers and key considerations

- The aim was well supported in its present form; however, there is a need for minor revision to provide greater consistency and clarity of purpose and to complement and better reflect the amended rationale, objectives and outcomes.
- The aim requires some revision with regards to the representation of the principles, specific nature and characteristics of chemistry.
- The aim will be reviewed to ensure consistency of length, detail and complexity with other senior syllabuses.

6. 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.

Proposed objectives for Chemistry Senior Years

Values and attitudes

Students:

- develop positive, informed values and attitudes towards chemistry
- recognise the importance and relevance of chemistry in their lives now and for the future.

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 in chemistry
- develop knowledge and understanding of the interactions in chemistry
- develop knowledge and understanding of the applications of chemistry.

Actions for writers and key considerations

- Review the objectives to ensure consistency with the amended rationale, aim and outcomes of the course.
- Enhance the concept of Science as a Human Endeavour in the values and attitudes objectives.

7. Outcomes

ⓘ for your information

In NSW syllabuses, outcomes provide detail about what students are expected to achieve at the end of each Stage 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.

Proposed outcomes for Chemistry Senior Years

The following table presents a sample of some of the proposed outcomes**.**

Values and attitudes

Objectives Students: • develop positive, informed values and attitudes towards chemistry • recognise the importance and relevance of chemistry in their lives now and for the future.

Skills

Objective Students: • develop skills in applying Working Scientifically.	
Year 11 outcomes A student:	**Year 12 outcomes** A student:
CHP-1 proposes questions or hypotheses to be investigated scientifically and predicts outcomes	CHH-1 evaluates questions and/or hypotheses to be investigated scientifically and predicts evidence-based outcomes
CHP-2 designs investigations, considers risks and ethical issues, identifies appropriate materials and suggests related data for collection	CHH-2 justifies the design of risk-assessed, ethical investigations involving appropriate materials and selects and collects relevant primary and secondary sourced data

Knowledge and understanding

Year 11 Course Unit 1
Objective Students: • develop knowledge and understanding of the fundamentals of chemistry
Year 11 outcomes A student:
CHP-8 describes the physical, structural and chemical aspects of matter

Year 12 Course Unit 3
Objective Students: • develop knowledge and understanding of the interactions in chemistry
Year 12 outcomes A student:
CHH -8 explains the characteristics of equilibrium systems, and the factors that affect these system

Year 11 Course Unit 2
Objective Students: • develop knowledge and understanding of the trends in chemistry
Year 11 outcomes A student:
CHP-10 develops explanations for trends and relationships between elements in terms of atomic structure and bonding

Year 12 Course Unit 4
Objective Students: • develop knowledge and understanding of the applications of chemistry
Year 12 outcomes A student:
CHH-10 analyses the structure and predicts reactions involving carbon compounds

Actions for writers and key considerations

- Develop up to 10–12 skills and knowledge and understanding outcomes to complement the existing outcomes and to ensure that core content areas and skills development in chemistry are addressed.
- Ensure there is a coherent and logical development from Year 11 to Year 12, and that the outcomes provide detail with regards to the knowledge, understanding and skills expected to be gained. The outcomes should be derived from the objectives.
- The outcomes should build on and extend the Science K–10 continuum of learning.

8. Course structure

ⓘ for your information

The following provides an outline of the Year 11 and Year 12 course structure for the Chemistry Senior Years syllabus with indicative course hours and the arrangement of course content, along with outlining relationships between specific components and between core and options.

Proposed course structure for Chemistry Senior Years

	Chemistry	Indicative hours	Depth Studies
Year 11 course (120 hours)	**Unit 1** **Fundamentals of Chemistry**	60	
	Unit 2 **Trends in Chemistry**	45	15 hours for Depth Studies
Year 12 course (120 hours)	**Unit 3** **Interactions in Chemistry**	60/50*	10 hours for Depth Studies
	Unit 4 **Applications of Chemistry**	60/50*	

** 10 hours of Depth Studies may be undertaken in either Unit 3 or Unit 4 or the time may be shared across both the Units.*

Actions for writers and key considerations

The course structure requires some revision to enhance coherence with the other courses and ensure a logical development of interrelated ideas.

Further information is to be included in the syllabus about the nature and structure of Depth Studies. They are intended to be flexible, non-prescriptive areas for further study, selected to meet the needs of individual students.

They should:

- represent contemporary issues in chemistry
- provide opportunities for the diversity of learners
- extend students in areas of particular interest
- provide access to specific areas of science not included in the core content
- promote student engagement
- provide students with opportunities to apply their knowledge and further develop the skills, understandings gained in the course.

Describe how area(s) of study are selected and investigated at depth either individually, in a group or as a whole class activity. Information should include that a substantial component of first or second-hand investigative work and research is to be undertaken to assist students in applying the core content knowledge and skills.

Examples of activities that may be suitable for depth studies should be included. These include individual or group projects that may be chosen by students according to their interests and abilities. Examples of small and large-scale studies are to be provided along with recommended time allocations.

The examples should include a range of activities that result in a variety of outcomes. Some examples are:

- individual or group projects chosen by students according to their interests (eg the chemistry of pharmaceuticals, plastics and textiles, nuclear power, the chemistry of particular foods)
- a class-based in-depth study of an area (eg Redox reactions, electrochemical cells, applications of chemistry to medicine).

9. Content

ⓘ for your information

In NSW syllabuses for Senior Years, 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.

Organisation of the content

The Chemistry Senior Years draft syllabus will be organised in the following way:

<table>
<tr><td colspan="2">Year 11 Chemistry</td></tr>
<tr><td rowspan="2">Unit 1

Fundamentals of Chemistry</td><td>Properties and structures of matter
− Properties of matter
− Atomic structure and the Periodic Table
− Atomic mass
− Types of compounds
− Simple reactions</td></tr>
<tr><td>Quantitative chemistry
− Simple chemical interactions
− Mole concept
− Stoichiometry
− Energy in chemical reactions</td></tr>
<tr><td rowspan="2">Unit 2

Trends in Chemistry</td><td>Arrangement of the Periodic Table
− Types of matter
− Structure of the Periodic Table
− Types of intermolecular bonding</td></tr>
<tr><td>Types of chemical interactions
− Types of chemical interactions
− Rates of chemical reactions
− Factors affecting reaction rates</td></tr>
</table>

<table>
<tr><th colspan="2">Year 12 Chemistry</th></tr>
<tr><td rowspan="2">Unit 3

Interactions in Chemistry</td><td>Equilibrium reactions
− Equilibrium
− Types of equilibrium systems
− Calculating the equilibrium constant
− Factors that affect equilibrium</td></tr>
<tr><td>Acid/Base reactions
− Types of acids
− pH and pOH
− Strength of acids
− Volumetric analysis</td></tr>
<tr><td rowspan="2">Unit 4

Applications of Chemistry</td><td>Properties and structures of organic materials
− Nomenclature
− Functional groups
− Reaction types
− Uses of carbon compounds</td></tr>
<tr><td>Chemical synthesis and design
− Identification of materials
− Production of materials
− Chemical monitoring
− Redox reactions</td></tr>
</table>

Sample content

Fundamentals of Matter: Properties and Structures of Matter

Outcomes

A student:

- designs investigations, considers risks, ethical issues and identifies appropriate materials and suggests related data for collection CHP-2
- conducts investigations individually or in teams and methodically collects valid and reliability data from first-hand and secondary sources CHP-3
- processes first-hand and secondary sourced data, identifies trends, patterns and relationships and suggests sources of error CHP-4
- explores the physical, structural and chemical aspects of matter CHP-8

Content

The physical properties of matter can be used to separate mixtures.

Students:

- investigate the properties of substances which can be used to separate mixtures including:
  - particle size
  - solubility
  - magnetism
  - density
  - electrostatic attraction
  - melting point
  - boiling point (ACSCH026)

- design and conduct first-hand investigations to separate mixtures by:
  - filtration
  - evaporation
  - distillation

- calculate the mass of components of substances to determine their percentage composition by, for example
  - calculating the percentage of salt in sea water
  - calculating the percentage of iron filings in sand and filings mixture (ACSCH025)

- classify the components of a mixture in terms of elements and compounds

- use technology to model the differences between elements, compounds and mixtures

Depth Studies may include:

- Investigating the desalination process including the advantages and disadvantages of this technology
- Conducting a case study of the treatment of sewage in a select community in an emergent economy
- Analyse current research into the extraction of pigments from plants and their potential future uses.

Actions for writers and key considerations

- The content needs to focus on students developing an understanding of fundamental concepts and skills in chemistry.
- The scope and depth of content should be reviewed and reduced to provide opportunities for depth of learning, learning by practical experiences, and include problem-solving while achieving an overall reduction.
- The content should maintain a contemporary nature and should not refer to specific technologies or processes that may become redundant.
- The content, knowledge, understanding and skills should build on and extend the continuum of learning from Stage 5 Science.
- Analyse and select Australian curriculum content, and modify, reorder and supplement to align with and complement draft syllabus content as appropriate.
- Australian Curriculum – Science as a Human Endeavour – should be included and identified by the Australian curriculum coding.
- Identify, by underlining, specific terms for inclusion in and links to a glossary.
- Selected content should focus on developing understanding of the fundamental concepts and skills in chemistry, including problem-solving skills using quantitative data analysis.
- Appropriate and authentic opportunities to develop knowledge, understanding, skills, values and attitudes specific to learning across the curriculum areas should be identified by icons.

10. 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 Senior Years 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

Sample learning across the curriculum area for Chemistry Senior Years

Information and communication technology capability

Information and communication technology (ICT) can be used effectively and appropriately to access, create and communicate information and ideas, solve problems and work collaboratively. The Chemistry Senior Years draft syllabus provides students with opportunities to develop ICT capability when they develop design ideas and solutions, research science concepts and applications, investigate science 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. Digital technologies and aids, such as animations and simulations, provide opportunities to view phenomena and test predictions that cannot be investigated through practical experiences in the classroom, and may enhance students' understanding and engagement with science and technology.

Actions for writers and key considerations

- For each learning across the curriculum area develop a succinct statement that describes how the subject provides opportunities to develop knowledge, understanding, skills, values and attitudes related to the area and its relevance.

11. Glossary

ⓘ for your information

One glossary will be developed for each senior years learning area. The glossary to be developed for the Chemistry Senior Years draft syllabus will explain terms that will assist teachers in the interpretation of the subject. The glossary will be based on the NSW K–10 Science glossary and Australian curriculum Senior Years Science glossary.

Actions for writers and key considerations

- Identify and underline words and/or terms additional to those in the K–10 Science glossary in the content for inclusion in the Senior Years glossary.

12. Assessment and reporting

ⓘ for your information

BOSTES continues to promote a standards-referenced approach to assessing and reporting student achievement in NSW, and the importance of assessment for, of and as learning as essential components of quality teaching and learning.

Information on assessment and reporting for the Year 11 and Year 12 courses will be reviewed and developed for draft syllabus consultation in 2016.

The information will include:

- mandatory components and weightings for school-based assessment of the HSC course
- HSC examination specifications which describe the format of the HSC examination program for Chemistry.

13. Appendix I

Broad directions from consultation

The following broad directions for syllabus development have been informed through consultation with stakeholders. These broad directions will guide the development of the NSW Chemistry Senior Years syllabuses.

1. In the revision and development of the courses, consideration be given to how the courses provide flexibility to meet the needs of all students.

2. In the revision of the current content-heavy courses provision be made for the reduction and integration of content. This may be organised using the concept of Big Ideas of Science.

3. The nature and practice of Science is reflected in the inclusion of working scientifically using first-hand investigations, secondary sources, models and modelling.

4. The Science courses be reviewed to allow flexibility of pedagogy and delivery. This may include cross-disciplinary study, project based/research and STEM learning.

5. Opportunities be considered to extend students' learning in Science by revising each course's content and requirements.

6. The Senior Science course rationale, structure and assessment requirements be reviewed to focus on developing scientifically literate students.

7. The Senior Science course rationale, structure and assessment requirements be reviewed with a focus to support a range of post-school contexts.

8. Assessment and HSC examination specifications be reviewed to ensure appropriate opportunities for assessment of a wide range of student performance including assessing analytical and critical thinking, first-hand investigations, the use of secondary sources and research projects.

9. The Science syllabuses should provide for the continual inclusion of contemporary and relevant material.

10. The rationale, outcomes and content of the Stage 6 Science Life Skills course be reviewed to better meet the needs of the students for whom the course is intended, as well as provide an appropriate progression from Stage 5 Science Life Skills outcomes and content and alignment with the regular Stage 6 Science courses where appropriate.

14. Appendix II

Key matters raised during draft writing brief consultation and actions

Key matters	Actions
Option 2 is preferred. However, there is strong support for Option 3 with its depth study component.	Aspects of Options 2 and 3 will be incorporated.
The rationale, aim and objectives require some revision to provide more clarity and consistency of purpose around the principles of chemistry.	The rationale, aim and objectives will be reviewed and amended to provide clarity and consistency.
There is a need for a quantitative, analytical emphasis in the course, with a focus on physical understanding, modelling and problem-solving using data analysis.	Quantitative analytical aspects will be included and addressed through a review of the modules and areas of study.
The concept of depth studies is supported. However, assessment for the HSC requires further investigation	Depth studies will be included, and details about their nature and structure will be provided.
The Chemistry syllabus should emphasise learning science as it is practised and promote practical investigations and activities.	Where appropriate, practical investigations and activities will enhance and compliment the content.
Development of an Extension course(s) for Science should be considered.	An Extension course(s) in Science will be considered for development during syllabus development in the science courses.
Senior Years assessment policies, procedures and requirements should be reviewed and clarified.	Senior Years assessment policies and procedures will be reviewed during draft syllabus development.