BOSTES | BOARD OF STUDIES TEACHING & EDUCATIONAL STANDARDS NSW

Physics
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 *Physics 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 Senior Years syllabus. Each element includes proposed actions and key considerations for writers in the writing if the draft syllabus. These elements are:

- Rationale
- The place of the Physics 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 Physics 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. Physics key

ⓘ for your information

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

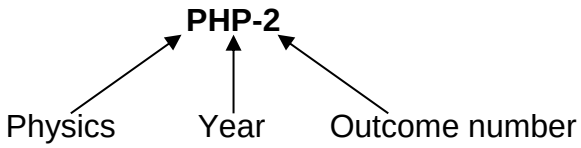
Outcome coding

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



Coding of Australian curriculum content

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

Actions for writers and key considerations

- Identify Australian curriculum content descriptions by using Australian curriculum codes.
- The codes 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 Physics Senior Years

Students of Senior Years Physics will learn that, as physicists, 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 creativity and imaginatively. This subject will also provide a foundation for students to critically consider information and to make informed decisions about contemporary Physical 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 physics at tertiary level.

Our scientific knowledge and understanding and methods of working scientifically have led physicists to gain a better understanding of the natural phenomena that occur in the universe. By working scientifically and using models, laws and theories, 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 Physics involves using differing scales including macro-, micro- and nano-scales; using specialised representations such as formulae and equations; visualising, explaining and predicting physical phenomena and being creative, as when examining the diverse phenomena when analysing how systems interact throughout the universe on multiple scales. The study of Physics 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 physical knowledge and understanding will be required to tackle major global issues and challenges now and into the future. These include issues of sustainability, efficient production and use of energy, the interrelationship between energy and matter, and Earth’s position in the universe including the exploration of space.

Actions for writers and key considerations

- The rationale requires some revision to provide clarity and consistency of purpose with regard to the principles of physics, and to complement and better reflect the specific nature and characteristics of Physics.
- 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 Physics 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 Physics Senior Years

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

- appreciation of physics as an experimental science where models and theories are refined and new models and theories are developed through independent and collaborative research that continues to have significant impacts on society
- abilities to debate and critically evaluate scientific arguments and claims, communicate to a range of audiences physical understanding or findings and to propose possible solutions to problems
- understanding of the theories and models used to describe, explain and make predictions about physical 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 all living things and the environment and an understanding of how physics and physical practices are used and are integral to developments in many fields of human endeavour.

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 physics, and removal of inappropriate references.
- 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 Physics Senior Years

Values and attitudes

Students:

- develop positive, informed values and attitudes towards Physics
- recognise the importance and relevance of Physics 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 mechanics
- develop knowledge and understanding of energy
- develop knowledge and understanding of fields
- develop knowledge and understanding of contemporary physics.

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 Physics 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 physics • recognise the importance and relevance of physics 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:
PHP-1 proposes questions or hypotheses to be investigated scientifically and predicts outcomes	PHH-1 evaluates questions and/or hypotheses to be investigated scientifically and predicts evidence-based outcomes
PHP-2 designs investigations, consider risks, ethical issues and identifies appropriate materials and suggests related data for collection	PHH-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 Mechanics	
Year 11 outcomes A student:	
PHP-8	describes and analyses motion in terms of scalar and vector quantities and makes quantitative measurements for distance, displacement, speed velocity and acceleration.

Year 12 Course Unit 3	
Objective Students: • develop knowledge and understanding of Fields	
Year 12 outcomes A student:	
PHH-8	analyses and evaluates investigations into uniform circular motion, projectile motion, satellite motion and gravitational phenomena.

Year 11 Course Unit 2	
Objective Students: • develop knowledge and understanding of Energy	
Year 11 outcomes A student:	
PHP-10	explains and analyses wave interactions and the effects of those interactions in regard the transfer of energy.

Year 12 Course Unit 4	
Objective Students: • develop knowledge and understanding of Contemporary Physics	
Year 12 outcomes A student:	
PHH-10	describes and analyses the structure of the nucleus, radioactivity, natural and artificial transmutations, thermodynamics and quantum physics.

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 physics 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 Physics 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 Physics Senior Years

	Physics	Indicative hours	Depth studies
Year 11 course (120 hours)	**Unit 1** **Mechanics**	60	
	Unit 2 **Energy**	45	15 hours for depth studies
Year 12 course (120 hours)	**Unit 3** **Fields**	60/50*	10 hours for depth studies
	Unit 4 **Contemporary Physics**	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. Depth studies should include areas of prominent current research in physics in Australia such as astronomy, medical physics and photonics.

They should:

- represent contemporary issues in physics
- 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 physics of bridges, factors that affect terminal velocity, nuclear power, the physics of stars).
- A class-based in-depth study of an area (eg simple harmonic motion, the origins of the universe, applications of physics to medicine, special relativity or photonics).

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 Physics Senior Years syllabus will be organised in the following way:

<table>
<tr><td colspan="2">Year 11 Physics</td></tr>
<tr><td rowspan="2">Unit 1
Mechanics</td><td>Kinematics
− Scalars and vectors
− Representations of motion
− Straight Line Motion</td></tr>
<tr><td>Dynamics
− Newton’s Laws of motion
− Momentum
− Energy
− Conservation Laws</td></tr>
<tr><td rowspan="2">Unit 2
Energy</td><td>Waves
− Wave properties
− Properties of sound
− Properties of light
− Properties of electromagnetic waves</td></tr>
<tr><td>Electricity and Magnetism
− Electrostatics
− Magnetism
− Electric circuits
− Ohms Law
− Analysis of electrical circuits</td></tr>
</table>

<table>
<tr><td colspan="2">Year 12 Physics</td></tr>
<tr><td rowspan="2">Unit 3
Fields</td><td>Gravity
− Universal gravitation
− Motion of satellites
− Projectile motion
− Kepler Laws</td></tr>
<tr><td>Electromagnetism
− Electric and magnetic fields
− The Motor Effect
− Electromagnetic induction</td></tr>
<tr><td rowspan="2">Unit 4
Contemporary Physics</td><td>Particle Physics
− Atomic structure
− Radioactivity
− Transmutations
− Thermal physics
− Quantum physics and photons</td></tr>
<tr><td>Applications of Physics
− Using special relativity
− Communication technologies
− Energy technologies
− Analytical technologies</td></tr>
</table>

Sample content

Mechanics: Dynamics

Outcomes

A student:

- plans and performs scientific investigations PHP2.
- analyses and communicates the results of scientific investigations PHP3.
- describes and analyses motion in terms of scalar and vector quantities and makes quantitative measurements for distance, displacement, speed velocity and acceleration PHP8
- describes and explains events in terms of Newton's Laws, the Law of Conservation of Momentum and relativity PHP9

Content

Newton's Laws along with the Principle of Conservation of Momentum and the transformations of energy between kinetic, gravitational potential and other forms allow us to analyse objects in motion.

Students:

- investigate the motion of objects under a variety of circumstances, to determine:
  - the relationship between force, mass and acceleration.
  - the transfer of momentum in collisions between objects.
  - the transformation of energy between objects. (ACSPH065)
- explain the distinction between scalar and vector quantities (ACSPH060)
- analyse and solve problems using Newton's Laws of Motion. (ACSPH063)
- analyse and solve problems using the Principle of the Conservation of Momentum. (ACSPH064)
- describe the distinction between inelastic and elastic collisions. (ACSPH066)
- describe transformations between kinetic energy, gravitational potential energy and other forms of energy.
- solves quantitative physics problems by applying the formulae:
  - $\Delta F = ma$
  - $\Delta P_{Before} = \Delta P_{After}$
  - $\Delta F = \Delta P/t$
  - $W = Fd$
  - $KE = mv^2/2$
  - $GPE = mgh$
- Investigate applications of Newton's Laws and momentum conservation and energy transformations in society. (ACSPH055)

Suggested Depth Studies may include:

- Investigate the mechanics of car safety and suggest the development of innovative safety devices.
- Investigating a vehicle accident through the application of the laws of motion.
- Investigating the mechanics of flight.
- Using mechanics to design a bridge to span a particular geographic feature.
- Apply mechanics to biological systems.
- Research elastic potential energy, Hooke's Law or Simple Harmonic Motion.
- Photonics, where are we, what's next?

Actions for writers and key considerations

- The content needs to focus on students developing an understanding of fundamental concepts and skills in physics including mathematical and problem-solving skills.
- The scope and depth of content should be reviewed and reduced to provide opportunities 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.
- The content needs to focus on students developing an understanding of fundamental concepts and skills in physics including mathematical and problem-solving skills using quantitative data analysis and mathematical calculations.
- 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.
- 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 Physics 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 Senior Years Physics 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 Physics 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 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 Physics.

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 Physics Stage 6 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 Science Life Skills Stage 6 course be reviewed to better meet the needs of the students for whom the course is intended, as well as to provide an appropriate progression from Science Life Skills Stage 5 outcomes and content and alignment with the regular Science Stage 6 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 components.	Aspects of Options 2 and 3, including depth studies, will be incorporated.
The rationale, aim and objectives require some revision to provide more clarity and consistency of purpose about the principles of physics.	The rationale, aims and objectives will be reviewed and amended to provide clarity and consistency.
There is a need for 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 clarification.	Depth studies will be included and details about their nature and structure will be provided.
The Physics syllabus should emphasise learning science as it is practised, and promote practical investigations and activities.	Where appropriate, practical investigations and activities will be included to enhance and complement content.
Development of an Extension course(s) for sciences should be considered.	An Extension course(s) in Science will be considered for development following draft syllabus development in the science courses.
Senior Years assessment policies, procedures and requirements need clarification.	Senior Years assessment policies and procedures will be reviewed during draft syllabus development.