ANU H Course
Astrophysics

Written under the Science Framework

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Australian National University

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https://www.anu.edu.au/giving/impact-stories/talent-is-everywhere-opportunity-is-not

Fiona Foley, Winged harvest 2001, Wood, aluminium, ochre, and stainless steel, commissioned 2000 (WEH Stanner Building courtyard)

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H Courses

H classification is given to a year 11 and 12 course which is designed and accredited by the Board of Senior Secondary Studies (BSSS) and an Australian university, and where successful completion of the course will be recognised both towards the ACT Senior Secondary Certificate and an undergraduate degree with that university.

The BSSS considers H courses as complementary to studies in the home college. These extension courses allow students to pursue depth of study in an area of interest, while also gaining experience in a tertiary context to prepare for future studies.

The ACT Senior Secondary System

The ACT senior secondary system recognises a range of university, vocational or life skills pathways.

The system is based on the premise that teachers are experts in their area: they know their students and community and are thus best placed to develop curriculum and assess students according to their needs and interests. Students have ownership of their learning and are respected as young adults who have a voice.

A defining feature of the system is school-based curriculum and continuous assessment. School-based curriculum provides flexibility for teachers to address students' needs and interests. College teachers have an opportunity to develop courses for implementation across ACT schools. Based on the courses that have been accredited by the BSSS, college teachers are responsible for developing programs of learning. A program of learning is developed by individual colleges to implement the courses and units they are delivering.

Teachers must deliver all content descriptions; however, they do have flexibility to emphasise some content descriptions over others. It is at the discretion of the teacher to select the texts or materials to demonstrate the content descriptions. Teachers can choose to deliver course units in any order and teach additional (not listed) content provided it meets the specific unit goals.

School-based continuous assessment means that students are continually assessed throughout years 11 and 12, with both years contributing equally to senior secondary certification. Teachers and students are positioned to have ownership of senior secondary assessment. The system allows teachers to learn from each other and to refine their judgement and develop expertise.

Senior secondary teachers have the flexibility to assess students in a variety of ways. For example: multimedia presentation, inquiry-based project, test, essay, performance and/or practical demonstration may all have their place. College teachers are responsible for developing assessment instruments with task specific rubrics and providing feedback to students.

The integrity of the ACT Senior Secondary Certificate is upheld by a robust, collaborative, and rigorous structured consensus-based peer reviewed moderation process. System moderation involves all year 11 and 12 teachers from public, non-government and international colleges delivering the ACT Senior Secondary Certificate.

Only students who desire a pathway to university are required to sit a general aptitude test, referred to as the ACT Scaling Test (AST), which moderates student scores across courses and colleges. Students are required to use critical and creative thinking skills across a range of disciplines to solve problems. They are also required to interpret a stimulus and write an extended response.

Senior secondary curriculum makes provision for student-centred teaching approaches, integrated and project-based learning inquiry, formative assessment, and teacher autonomy. ACT Senior Secondary Curriculum makes provision for diverse learners and students with mild to moderate intellectual disabilities, so that all students can achieve an ACT Senior Secondary Certificate.

The ACT Board of Senior Secondary Studies (BSSS) leads senior secondary education. It is responsible for quality assurance in senior secondary curriculum, assessment, and certification. The Board consists of nominees from colleges, professional bodies, universities, industry, parent/carer organisations and unions. The Office of the Board of Senior Secondary Studies (OBSSS) consists of professional and administrative staff who support the Board in achieving its objectives and functions.

ACT Senior Secondary Certificate

Courses of study for the ACT Senior Secondary Certificate:

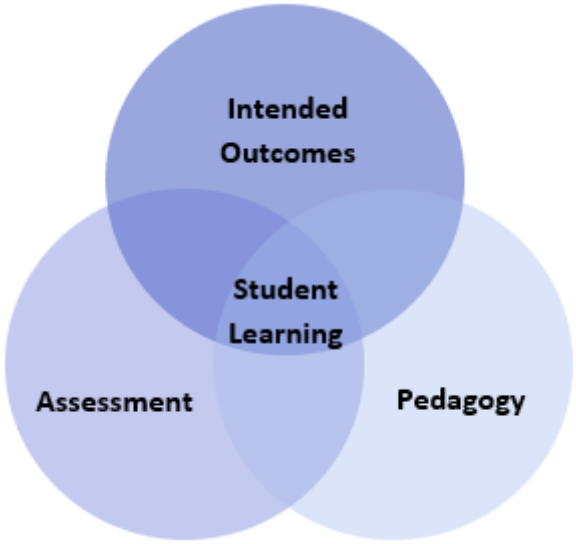
- provide a variety of pathways, to meet different learning needs and encourage students to complete their secondary education
- enable students to develop the essential capabilities for twenty-first century learners
- empower students as active participants in their own learning
- engage students in contemporary issues relevant to their lives
- foster students' intellectual, social, and ethical development
- nurture students' wellbeing, and physical and spiritual development
- enable effective and respectful participation in a diverse society.

Each course of study:

- comprises an integrated and interconnected set of knowledge, skills, behaviours, and dispositions that students develop and use in their learning across the curriculum
- is based on a model of learning that integrates intended student outcomes, pedagogy, and assessment
- outlines teaching strategies which are grounded in learning principles and encompass quality teaching
- promotes intellectual quality, establish a rich learning environment, and generate relevant connections between learning and life experiences
- provides formal assessment and certification of students' achievements.

Underpinning beliefs

- All students are able to learn.
- Learning is a partnership between students and teachers.
- Teachers are responsible for advancing student learning.



Learning Principles

1. Learning builds on existing knowledge, understandings, and skills.
   (Prior knowledge)
2. When learning is organised around major concepts, principles, and significant real world issues, within and across disciplines, it helps students make connections and build knowledge structures.
   (Deep knowledge and connectedness)
3. Learning is facilitated when students actively monitor their own learning and consciously develop ways of organising and applying knowledge within and across contexts.
   (Metacognition)
4. Learners' sense of self and motivation to learn affects learning.
   (Self-concept)
5. Learning needs to take place in a context of high expectations.
   (High expectations)
6. Learners learn in different ways and at different rates.
   (Individual differences)
7. Different cultural environments, including the use of language, shape learners' understandings and the way they learn.
   (Socio-cultural effects)
8. Learning is a social and collaborative function as well as an individual one.
   (Collaborative learning)
9. Learning is strengthened when learning outcomes and criteria for judging learning are made explicit and when students receive frequent feedback on their progress.
   (Explicit expectations and feedback)

General Capabilities

All courses of study for the ACT Senior Secondary Certificate should enable students to develop essential capabilities for twenty-first century learners. These 'capabilities' comprise an integrated and interconnected set of knowledge, skills, behaviours and dispositions that students develop and use in their learning across the curriculum.

The capabilities include:

- literacy
- numeracy
- information and communication technology (ICT)
- critical and creative thinking
- personal and social
- ethical understanding
- intercultural understanding

Courses of study for the ACT Senior Secondary Certificate should be both relevant to the lives of students and incorporate the contemporary issues they face. Hence, courses address the following three priorities. These priorities are:

- Aboriginal and Torres Strait Islander histories and cultures
- Asia and Australia's engagement with Asia
- Sustainability.

Elaboration of these General Capabilities and priorities is available on the ACARA website at www.australiancurriculum.edu.au.

Literacy

In ANU H Course Astrophysics, students become literate as they develop the knowledge, skills, and dispositions to interpret and use language confidently for listening, engaging in collaborative practice, and expressing their conclusions. Literacy in ANU H Course Astrophysics involves students listening to, reading, viewing, speaking, writing, and creating academic texts, and using and modifying language for a university context.

Numeracy

In ANU H Course Astrophysics, students become numerate as they develop the knowledge and skills to use complex mathematics confidently to create and interpret data as they research and communicate their findings in experiments and studies. Contexts that draw on Asian scientific research and development and collaborative endeavours in the Asia Pacific region provide an opportunity for students to investigate *Asia and Australia's engagement with Asia*. Students could examine the important role played by people of the Asia region in Astrophysics. They could consider collaborative projects between Australian and Asian scientists and the contribution these make to scientific knowledge.

Information and Communication Technology (ICT) Capability

In ANU H Course Astrophysics, students develop Information and Communication Technology (ICT) capability as they learn to use ICT effectively and appropriately to access, create and communicate information and ideas, solve problems and work collaboratively. They consider the role of ICT in gathering data in Astrophysics. ICT capability involves students learning to make the most of the digital technologies available to them at ANU, adapting to new ways of studying and being, as technologies evolve and understanding the risks to themselves and others in a digital environment.

Critical and Creative Thinking

In ANU H Course Astrophysics, students develop capability in critical and creative thinking as they learn to generate and evaluate knowledge, clarify concepts and ideas, seek possibilities, consider alternatives, and solve problems in Astrophysics. They engage in thinking critically about issues in Astrophysics and the ways different theories highlight and obscure different questions and opportunities. Critical and creative thinking involves students thinking broadly and deeply using skills, behaviours, and dispositions such as reason, logic, resourcefulness, imagination, and innovation.

Personal and Social Capability

In ANU H Course Astrophysics, students develop personal and social capability as they learn to understand themselves and others, and manage their relationships, lives, work and learning more effectively by learning and collaborating in a university context. They develop the skills to engage in respectful and thoughtful discussion and investigation of significant and controversial issues. As they investigate questions in Astrophysics in the unfamiliar university context, they build personal and social capability through a range of practices including recognising and regulating emotions, developing empathy for others and understanding relationships, establishing and building positive relationships, making responsible decisions, working effectively in teams, handling challenging situations constructively and developing leadership skills.

Ethical Understanding

In ANU H Course Astrophysics, students develop ethical understanding, as they identify and investigate the nature of ethical concepts and values and understand how reasoning can assist ethical judgement. Ethical understanding involves students building a strong personal and socially oriented ethical outlook that helps them to manage context, conflict and uncertainty, and to develop an awareness of the influence that their values and behaviour have on others through the exploration of their ethics as researchers and thinkers.

Intercultural Understanding

In ANU H Course Astrophysics, students develop intercultural understanding as they learn to value their own cultures, languages, and beliefs, and those of others though collaborating at university with students from many backgrounds. Intercultural understanding involves students learning about and engaging with diverse cultures in ways that recognise commonalities and differences, create connections with others and cultivate mutual respect.

Cross-Curriculum Priorities

Aboriginal and Torres Strait Islander Histories and Cultures

The Aboriginal and Torres Strait Islander histories and cultures priority provides the opportunity for all young Australians to gain a deeper understanding and appreciation of Aboriginal and Torres Strait Islander histories and cultures, deep knowledge traditions and holistic world views. This knowledge and understanding provided in ANU H Course Astrophysics, will enrich all learners' ability to participate positively in the ongoing development of Australia through a deepening knowledge and connection with the world's oldest continuous living cultures and the ways indigenous Australians have perceived and measured the cosmos.

Asia and Australia's Engagement with Asia

Contexts that draw on Asian scientific research and development and collaborative endeavours in the Asia Pacific region provide an opportunity for students to investigate *Asia and Australia's engagement with Asia*. Students could examine the important role played by people of the Asia region in Astrophysics. They could consider collaborative projects between Australian and Asian scientists and the contribution these make to scientific knowledge.

Sustainability

Students engage with sustainability as they become acutely aware of 'Spaceship Earth' and the unique and vulnerable character of life on our planet. This priority in ANU H Course Astrophysics, provides the opportunity for students to develop an appreciation of the necessity of acting for a more sustainable future and so address the ongoing capacity of Earth to maintain all life and meet the needs of the present without compromising the needs of future generations.

ANU H Course

Astrophysics

Rationale

This course is intended for students in Year 11 and 12 who have an interest and aptitude in Astrophysics and who require the skills and/or background covered in this course for further study at tertiary level.

Astrophysics is a fundamental science that endeavours to explain all the natural phenomena that occur in the universe. Its power lies in the use of a comparatively small number of assumptions, models, laws, and theories to explain a wide range of phenomena across a range of temporal and spatial scales. Astrophysics has helped to unlock the mysteries of the universe and has led to discoveries in technological and other scientific fields.

Astrophysics uses qualitative and quantitative models and theories based on physical laws to visualise, explain, and predict physical phenomena. Models, laws, and theories are developed from, and their predictions are tested by making observations and quantitative measurements. In this course, students gather, analyse, and interpret primary and secondary data to investigate a range of phenomena and technologies using some of the most important models, laws, and theories of astrophysics.

Scientific processes test current understandings and are continually re-evaluated. Students are challenged to examine and reconsider their understanding of scientific concepts, inquiry methods and phenomena. Students apply their knowledge of science to solve problems, make evidence-based decisions and engage in debates about science and its implications. The study of Astrophysics explores ways in which scientists work collaboratively and individually in a range of integrated fields to increase understanding of an ever-expanding body of scientific knowledge.

Students will benefit from learning in the university context. They will extend and develop understanding, knowledge and skills established in BSSS courses by applying that capacity to new and more complex Astrophysics problems. They will develop their personal and social capability by working collaboratively with academics and students from a wide range of contexts to investigate fundamental physical processes. In studying at the university context, meeting the expectations of academics, and using university facilities students will enhance their capacity to transition to further study at university.

Goals

- sense of wonder and curiosity about nature and an appreciation of how scientific knowledge can be used to address contemporary issues
- understanding of the theories and models used to describe, explain and make predictions about systems, structures and properties to provide a reliable basis for action
- understanding that scientific knowledge is developing over time, is being used in a variety of contexts; and influences, and is continuing to be influenced by, historical, social, economic, cultural and ethical considerations and new discoveries understanding that Science is experimental and has developed through independent and collaborative research, and has significant impacts on society and implications for decision making
- ability to design and conduct a variety of field and laboratory investigations involving collection and critical analysis of data, and interpretation of evidence

- ability to critically evaluate scientific concepts, interpretations and claims in order to solve problems and generate informed, considered, and ethical conclusions
- ability to communicate scientific understanding, findings, arguments, and conclusions using appropriate representations, modes, and genres.

Unit Titles

- Unsolved Mysteries and Exoplanets
- Supernovae, Black Holes and Cosmology

Organisation of Content

Unsolved Mysteries and Exoplanets

Students investigate a range of astrophysical phenomena in order to gain an understanding of the origins and nature of the universe. They extend their understanding of Newtonian Physics to analyse motion in space. Students represent and interpret data drawn from their analyses of questions about the evolution of universe, the formation of stars, origins of the elements and formation of solar systems. They engage with methodology, research, arguments and philosophical positions about the discovery and nature of exoplanets and the nature of life. Students extend skills as physicists by applying knowledge of the laws of physics, such as thermodynamics, to exoplanets, and by evaluating theories and conclusions based on physical laws, theorems, observational data, and complex data sets. They extend their skills in scientific communication through engaging with university level texts and extending their skills in communicating their findings in the university context.

Supernovae, Black Holes and Cosmology

Students engage with ongoing debate about the origin and nature of supernovae, black holes, and the cosmos. They extend their understanding of data collection, statistical analysis, representation of data, and interpretation of statistical data. Students study sources of electromagnetic radiation in the universe, and the nature of dark matter, dark energy, and their relationship to the expanding universe. Students study the role of the theory of general relativity in understanding the expanding universe. They refine their understanding of the production of scientific knowledge through the critical appraisal and evaluation of models, simulations and arguments derived from them. They extend their skills in scientific communication through collaborative process and the communication of their conclusions from scientific analysis.

Assessment

The identification of criteria within the achievement standards and assessment tasks types and weightings provide a common and agreed basis for the collection of evidence of student achievement.

Assessment Criteria (the dimensions of quality that teachers look for in evaluating student work) provide a common and agreed basis for judgement of performance against unit and course goals, within and across colleges. Over a course, teachers must use all these criteria to assess students' performance but are not required to use all criteria on each task. Assessment criteria are to be used holistically on a given task and in determining the unit grade.

Assessment Tasks elicit responses that demonstrate the degree to which students have achieved the goals of a unit based on the assessment criteria. The Common Curriculum Elements (CCE) is a guide to developing assessment tasks that promote a range of thinking skills (see Appendix C). It is highly desirable that assessment tasks engage students in demonstrating higher order thinking.

Rubrics are constructed for individual tasks, informing the assessment criteria relevant for a particular task, and can be used to assess a continuum that indicates levels of student performance against each criterion.

Assessment Criteria

Students will be assessed on the degree to which they demonstrate understanding of:

- concepts, models, and application
- contexts
- inquiry skills.

Assessment Task Types

Suggested tasks

Individual tasks may incorporate one or more of the following:

- models
- commentary
- debate
- portfolio/journal
- field work
- investigation
- document/source analysis
- practical report
- role play
- research report
- test/quiz
- seminar/workshop/lecture
- poster
- response to stimulus
- essay
- multimedia presentation
- creative response
- interview
- discussion forum
- rationale/validation
- practical skills

It is recommended that a student conceived investigation be undertaken at least once during a minor and twice during a major. This investigation may either be theoretical or practical or a combination of both.

Weightings in T 1.0:

No task to be weighted more than 45% for a standard 1.0 unit

Additional Assessment Information

- For a standard unit (1.0), students must complete a minimum of three assessment tasks and a maximum of five.
- Students must experience a variety of task types and different modes of communication to demonstrate the Achievement Standards in both theoretical and practical tasks.
- All Achievement Standards must be demonstrated in standard (1.0).
- Task types need to be selected to address all Achievement Standards within the Concepts, Models and Applications, Contexts, and Inquiry Skills strands across a standard (1.0).
- For tasks completed in unsupervised conditions, schools need to have mechanisms to uphold academic integrity, for example: student declaration, plagiarism software, oral defence, interview, or other validation tasks.

Achievement Standards

A Year 12 student in any unit is assessed using the Year 12 achievement standards. A Year 11 student in any unit is assessed using the Year 11 achievement standards. Year 12 achievement standards reflect higher expectations of student achievement compared to the Year 11 achievement standards. Years 11 and 12 achievement standards are differentiated by cognitive demand, the number of dimensions and the depth of inquiry.

An achievement standard cannot be used as a rubric for an individual assessment task. Assessment is the responsibility of the college. Student tasks may be assessed using rubrics or marking schemes devised by the college. A teacher may use the achievement standards to inform development of rubrics. The verbs used in achievement standards may be reflected in the rubric. In the context of combined Years 11 and 12 classes, it is best practice to have a distinct rubric for Years 11 and 12. These rubrics should be available for students prior to completion of an assessment task so that success criteria are clear.

Achievement Standards for Science T Course – Year 11

	*A student who achieves an **A** grade typically*	*A student who achieves a **B** grade typically*	*A student who achieves a **C** grade typically*	*A student who achieves a **D** grade typically*	*A student who achieves an **E** grade typically*
Concepts, Models and	• critically analyses the fundamental properties and functions of system components, processes and interactions, and the effects of factors across a range of scales • evaluates the nature, functions, limitations and applications of theories and models using evidence, in unfamiliar contexts • analyses evidence with reference to models and/or theories, and develops evidence-based conclusions and evaluates limitations	• analyses the fundamental properties and functions of system components, processes and interactions, and the effects of factors across a range of scales • analyses the nature, functions, limitations and applications of theories and models using evidence, in familiar contexts • assesses evidence with reference to models and/or theories, and develops evidence-based conclusions and discusses limitations	• explains the fundamental properties and functions of system components, processes and interactions and the effects of factors across a range of scales • explains the nature, functions, limitations and applications of theories and models using evidence, in familiar contexts • explains evidence with reference to models and/or theories, and develops evidence-based conclusions and identifies limitations	• describes the fundamental properties and functions, and with some description of system components, processes and interactions, and the effects of factors across a range of scales • describes the nature, functions, limitations and applications of theories and models with supporting evidence • describes evidence, and develops conclusions with some reference to models and/or theories	• identifies the fundamental properties and functions of system and identifies components, processes and interactions, and the effects of factors across a range of scales • identifies the nature, functions, applications, and some possible limitations of theories and models, with some evidence • identifies evidence, and asserts conclusions with little or no reference to models and/or theories
Contexts	• critically analyses epistemology, role of peer review, collaboration, and technology in developing knowledge • critically analyses the influence of social, economic, ethical, and cultural factors on Science	• analyses epistemology, role of peer review and technology in developing knowledge • analyses the influence of social, economic, ethical, and cultural factors on Science	• explain epistemology, role of peer review and technology in developing knowledge • explains the influence of social, economic, ethical, and cultural factors on Science	• describes the role of peer review in developing knowledge • describes the influence of social, economic, ethical, and cultural factors on Science	• identifies that scientific knowledge has changed over time • identifies the influence of social, economic, ethical, and cultural factors on Science
Inquiry Skills	• designs, conducts and improves safe, ethical and original inquiries individually and collaboratively, that collect valid, reliable data in response to a complex question • analyses causal and correlational relationships, anomalies, reliability and validity of data and representations, and analyses errors • analyses processes and claims, and provides a critique based on evidence, and critically analyses alternatives • reflects on own thinking and evaluates planning, time management, use of appropriate work strategies • communicates concisely, effectively, and accurately, demonstrating scientific literacy in a range of modes, styles, representations, and genres for specific audiences and purposes, with appropriate evidence and accurate referencing	• designs, conducts, and improves safe, ethical inquiries individually and collaboratively, that collect valid, reliable data in response to a question • analyses causal and correlational relationships, anomalies, reliability and validity of data and representations, and discusses errors • assesses processes and claims, and provides a critique with reference to evidence, and analyses alternatives • reflects on their own thinking and analyses planning, time management, use of appropriate work strategies • communicates clearly and accurately, demonstrating scientific literacy in a range of modes, styles, representations and genres for specific audiences and purposes, with appropriate evidence and accurate referencing	• plans and conducts safe, ethical inquiries individually and collaboratively, that collect valid data in response to a familiar question • explains causal and correlational relationships, anomalies, reliability and validity of data and representations, and cites common errors • explains processes and claims, and identifies alternatives with reference to reliable evidence • reflects on their own thinking and explains planning, time management, use of appropriate work strategies • communicates accurately demonstrating scientific literacy, in a range of modes, styles, representations, and genres for specific purposes, with appropriate evidence and mostly consistent referencing	• follows a procedure to conduct safe, ethical inquiries individually and collaboratively, to collect data in response to a simple question with varying success • describes trends, relationships, and anomalies in data, identifies anomalies, and some possible sources of error • describes processes and claims, and identifies the need for improvements with some reference to evidence • reflects on their own thinking, with reference to planning and the use of appropriate work strategies • communicates demonstrating some scientific literacy, in a range of modes, representations, and genres with some evidence and inconsistent referencing	• follows a procedure to conduct safe, ethical inquiries individually and collaboratively, to collect data with little or no connection to a question • identifies trends and relationships in data, with little or no reference to sources of error • identifies processes and the need for some improvements, with little or no reference to evidence • reflects on their own thinking with little or no reference to planning, time management, and use of work strategies • communicates demonstrating limited scientific literacy, in a range of modes and representations, with inconsistent and inaccurate referencing

Achievement Standards for Science T Course – Year 12

	*A student who achieves an **A** grade typically*	*A student who achieves a **B** grade typically*	*A student who achieves a **C** grade typically*	*A student who achieves a **D** grade typically*	*A student who achieves an **E** grade typically*
Concepts, Models and Applications	• critically analyses the properties and functions of system components, processes and interactions, and the interplay and effects of factors across a range of scales • evaluates applications, limitations, and predictions of theories and models to explain systems and create solutions, with evidence, in unfamiliar contexts • evaluates evidence with reference to critical analysis of models and/or theories, and develops evidence-based conclusions and evaluates limitations	• analyses the properties and functions of system components, processes and interactions, and the interplay and effects of factors across a range of scales • analyses applications, limitations, and predictions of theories and models to explain systems and create plausible solutions, with evidence in familiar contexts • analyses evidence with reference to models and/or theories, and develops evidence-based conclusions and discusses limitations	• explains the fundamental properties and functions of system components, processes and interactions, and the effects of factors across a range of scales • explains applications, limitations, and predictions of theories and models to explain systems and create plausible solutions in familiar contexts • explains evidence with reference to models and/or theories, and develops evidence-based conclusions and identifies limitations	• describes the fundamental properties and functions of system components, processes and interactions, and the effects of one or more factors • describes the nature, functions, limitations and applications of theories and models to create solutions to problems with supporting evidence • describes evidence, and develops conclusions with some reference to models and/or theories	• identifies the fundamental properties and functions of system components, processes and interactions, and some affective factors • identifies the nature, functions, limitations and applications of theories and models, and suggest solutions to problems with supporting evidence • identifies evidence, and asserts conclusions with little or no reference to models and/or theories
Contexts	• critically analyses epistemology, role of peer review, collaboration, and technology in developing knowledge • critically analyses the influence of social, economic, ethical, and cultural factors on Science	• analyses epistemology, role of peer review and technology in developing knowledge • analyses the influence of social, economic, ethical, and cultural factors on Science	• explains epistemology, role of peer review and technology in developing knowledge • explains the influence of social, economic, ethical, and cultural factors on Science	• describes role of peer review and technology in developing knowledge • describes the influence of social, economic, ethical, and cultural factors on Science	• identifies that scientific knowledge has changed over time • identifies the influence of social, economic, ethical, and cultural factors on Science
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Unsolved Mysteries and Exoplanets Value: 1.0

Unit Description

Students investigate a range of astrophysical phenomena in order to gain an understanding of the origins and nature of the universe. They extend their understanding of Newtonian Physics to analyse motion in space. Students represent and interpret data drawn from their analyses of questions about the evolution of universe, the formation of stars, origins of the elements and formation of solar systems. They engage with methodology, research, arguments and philosophical positions about the discovery and nature of exoplanets and the nature of life. Students extend skills as physicists by applying knowledge of the laws of physics, such as thermodynamics, to exoplanets, and by evaluating theories and conclusions based on physical laws, theorems, observational data, and complex data sets. They extend their skills in scientific communication through engaging with university level texts and extending their skills in communicating their findings in the university context.

Specific Unit Goals

This unit should enable students to:

- understand theories about the origin and nature of the universe
- understand methodologies, data and conclusions about the origin and nature of exoplanets
- engage critically with contemporary research and communicate conclusions.

Content Descriptions

All knowledge, understanding and skills below must be delivered:

Concepts and Ideas

- analyse motions in space using Newtonian mechanics
- explain major events and their causes in the evolution of the universe, including the formation of the first stars and solar systems
- explain the formation of solar systems and the physical processes that drive the process
- evaluate and apply systematic problem-solving strategies to complicated problems in astrophysics, including dimensional analysis, estimation strategies and the use of diagrams
- analyse astrophysical data using graphical and statistical techniques.

Contexts

- apply computational tools to find numerical solutions to astrophysical problems and to model physical processes in astrophysics
- critically analyse scientific processes and their effectiveness in producing knowledge about the origin and nature of the universe and exoplanets.

Communication

- communicate concisely, effectively, and accurately, with scientific literacy for academic purposes
- represent physical and mathematical arguments and graphical data clearly and concisely for academic purposes.

Reflection

- reflect on own thinking and learning in the university context
- reflect on methods and ethics for individual and collaborative knowledge production in the university context
- evaluate own planning and time management strategies.

A guide to reading and implementing content descriptions

Content descriptions specify the knowledge, understanding and skills that students are expected to learn and that teachers are expected to teach. Teachers are required to develop a program of learning that allows students to demonstrate all the content descriptions. The lens which the teacher uses to demonstrate the content descriptions may be either guided through provision of electives within each unit or determined by the teacher when developing their program of learning.

A program of learning is what a college provides to implement the course for a subject. It is at the discretion of the teacher to emphasis some content descriptions over others. The teacher may teach additional (not listed) content provided it meets the specific unit goals. This will be informed by the student needs and interests.

Assessment

Refer to pages 10-12.

Supernovae, Black Holes and Cosmology Value: 1.0

Unit Description

Students engage with ongoing debate about the origin and nature of supernovae, black holes, and the cosmos. They extend their understanding of data collection, statistical analysis, representation of data, and interpretation of statistical data. Students study sources of electromagnetic radiation in the universe, and the nature of dark matter, dark energy, and their relationship to the expanding universe. Students study the role of the theory of general relativity in understanding the expanding universe. They refine their understanding of the production of scientific knowledge through the critical appraisal and evaluation of models, simulations and arguments derived from them. They extend their skills in scientific communication through collaborative process and the communication of their conclusions from scientific analysis.

Specific Unit Goals

This unit should enable students to:

- understand the nature of and relationship between dark matter, dark energy, and the expanding universe
- understand the physical processes behind the death of stars, including supernovae and the formation of black holes and their implications understand current theories about the early universe and its evolution
- use computational tools to filter, display, interpret and analyse data about supernovae, black holes, and cosmology.

Content Descriptions

All knowledge, understanding and skills below must be delivered:

Concepts and Ideas

- analyse evidence for dark matter, dark energy, and the standard cosmological model
- apply concepts from quantum mechanics, special and general relativity to explain the evolution of stars and the universe
- explain how observational data can be used to provide precise measurements of cosmological parameters
- analyse the role of entropy and thermodynamics in the evolution of the universe.

Contexts

- analyse and display data about supernovae, black holes and cosmology using computational tools
- explain the scientific method as applied in Astrophysics
- evaluate the use of technology in gathering data about supernovae, black holes, and cosmology.

Communication

- communicate concisely, effectively, and accurately, with scientific literacy for academic purposes
- represent physical and mathematical arguments and graphical data clearly and concisely for academic purposes.

Reflection

- reflect on own thinking and learning in the university context
- reflect on methods and ethics for individual and collaborative knowledge production in the university context
- evaluate own planning and time management strategies.

A guide to reading and implementing content descriptions

Content descriptions specify the knowledge, understanding and skills that students are expected to learn and that teachers are expected to teach. Teachers are required to develop a program of learning that allows students to demonstrate all the content descriptions. The lens which the teacher uses to demonstrate the content descriptions may be either guided through provision of electives within each unit or determined by the teacher when developing their program of learning.

A program of learning is what a college provides to implement the course for a subject. It is at the discretion of the teacher to emphasis some content descriptions over others. The teacher may teach additional (not listed) content provided it meets the specific unit goals. This will be informed by the student needs and interests.

Assessment

Refer to pages 10-12.

Appendix A – Implementation Guidelines

Available course patterns

A standard 1.0 value unit is delivered over at least 55 hours. To be awarded a course, students must complete at least the minimum units over the whole minor.

Course	Number of standard units to meet course requirements
Minor	Minimum of 2 units

Units in this course can be delivered in any order.

Co-requisites for the course or units within the course

Students must be enrolled in BSSS Physics in their home college to be eligible for this H Course. Also, it is recommended that students be enrolled in the Specialist Methods Mathematics course, or above.

Duplication of Content Rules

Students cannot be given credit towards the requirements for a Senior Secondary Certificate for a unit that significantly duplicates content in a unit studied in another course. The responsibility for preventing undesirable overlap of content studied by a student rests with the principal and the teacher delivering the course. Students will only be given credit for covering the content once.

Guidelines for Delivery

Program of Learning

A program of learning is what a school provides to implement the course for a subject. This meets the requirements for context, scope and sequence set out in the Board endorsed course. Students follow programs of learning in a college as part of their senior secondary studies. The detail, design, and layout of a program of learning are a college decision.

The program of learning must be documented to show the planned learning activities and experiences that meet the needs of particular groups of students, taking into account their interests, prior knowledge, abilities, and backgrounds. The program of learning is a record of the learning experiences that enable students to achieve the knowledge, understanding and skills of the content descriptions. There is no requirement to submit a program of learning to the OBSSS for approval. The Principal will need to sign off at the end of Year 12 that courses have been delivered as accredited.

Content Descriptions

Are all content descriptions of equal importance? No. It depends on the focus of study. Teachers can customise their program of learning to meet their own students' needs, adding additional content descriptions if desired or emphasising some over others. A teacher must balance student needs with their responsibility to teach all content descriptions. It is mandatory that teachers address all content descriptions and that students engage with all content descriptions.

Moderation

Moderation is a system designed and implemented to:

- provide comparability in the system of school-based assessment
- form the basis for valid and reliable assessment in senior secondary schools
- involve the ACT Board of Senior Secondary Studies and colleges in cooperation and partnership
- maintain the quality of school-based assessment and the credibility, validity, and acceptability of Board certificates.

Moderation commences within individual colleges. Teachers develop assessment programs and instruments, apply assessment criteria, and allocate Unit Grades, according to the relevant Framework. Teachers within course teaching groups conduct consensus discussions to moderate marking or grading of individual assessment instruments and unit grade decisions.

The Moderation Model

Moderation within the ACT encompasses structured, consensus-based peer review of Unit Grades for all accredited courses over two Moderation Days. In addition to Moderation Days, there is statistical moderation of course scores, including small group procedures, for T courses.

Moderation by Structured, Consensus-based Peer Review

Consensus-based peer review involves the review of student work against system wide criteria and standards and the validation of Unit Grades. This is done by matching student performance with the criteria and standards outlined in the Achievement Standards, as stated in the Framework. Advice is then given to colleges to assist teachers with, or confirm, their judgments. In addition, feedback is given on the construction of assessment instruments.

Preparation for Structured, Consensus-based Peer Review

Each year, teachers of Year 11 are asked to retain originals or copies of student work completed in Semester 2. Similarly, teachers of a Year 12 class should retain originals or copies of student work completed in Semester 1. Assessment and other documentation required by the Office of the Board of Senior Secondary Studies should also be kept. Year 11 work from Semester 2 of the previous year is presented for review at Moderation Day 1 in March, and Year 12 work from Semester 1 is presented for review at Moderation Day 2 in August.

In the lead up to Moderation Day, a College Course Presentation (comprised of a document folder and a set of student portfolios) is prepared for each A, T and M course/units offered by the school and is sent into the Office of the Board of Senior Secondary Studies.

The College Course Presentation

The package of materials (College Course Presentation) presented by a college for review on Moderation Days in each course area will comprise the following:

- a folder containing supporting documentation as requested by the Office of the Board through memoranda to colleges, including marking schemes and rubrics for each assessment item
- a set of student portfolios containing marked and/or graded written and non-written assessment responses and completed criteria and standards feedback forms. Evidence of all assessment responses on which the Unit Grade decision has been made is to be included in the student review portfolios.

Specific requirements for subject areas and types of evidence to be presented for each Moderation Day will be outlined by the Board Secretariat through the *Requirements for Moderation Memoranda* and Information Papers.

Visual evidence for judgements made about practical performances

It is a requirement that schools' judgements of standards to practical performances (A/T/M) be supported by visual evidence (still photos or video).

The photographic evidence submitted must be drawn from practical skills performed as part of the assessment process.

Teachers should consult the BSSS guidelines at:

http://www.bsss.act.edu.au/grade_moderation/moderation_information_for_teachers

for current information regarding all moderation requirements including subject specific and photographic evidence.

Appendix B – Course Developers

Name	College
Paul Francis	PhD; Astrophysicist, Mt Stromlo Observatory, and the Physics Education Centre, ANU
Brian Schmidt	PhD; Astronomer, Research School of Astronomy and Astrophysics, ANU

Appendix C – Common Curriculum Elements

Common curriculum elements assist in the development of high-quality assessment tasks by encouraging breadth and depth and discrimination in levels of achievement.

Organisers	Elements	Examples
create, compose, and apply	apply	ideas and procedures in unfamiliar situations, content, and processes in non-routine settings
	compose	oral, written, and multimodal texts, music, visual images, responses to complex topics, new outcomes
	represent	images, symbols, or signs
	create	creative thinking to identify areas for change, growth, and innovation, recognise opportunities, experiment to achieve innovative solutions, construct objects, imagine alternatives
	manipulate	images, text, data, points of view
analyse, synthesise, and evaluate	justify	arguments, points of view, phenomena, choices
	hypothesise	statement/theory that can be tested by data
	extrapolate	trends, cause/effect, impact of a decision
	predict	data, trends, inferences
	evaluate	text, images, points of view, solutions, phenomenon, graphics
	test	validity of assumptions, ideas, procedures, strategies
	argue	trends, cause/effect, strengths, and weaknesses
	reflect	on strengths and weaknesses
	synthesise	data and knowledge, points of view from several sources
	analyse	text, images, graphs, data, points of view
	examine	data, visual images, arguments, points of view
	investigate	issues, problems
organise, sequence, and explain	sequence	text, data, relationships, arguments, patterns
	visualise	trends, futures, patterns, cause, and effect
	compare/contrast	data, visual images, arguments, points of view
	discuss	issues, data, relationships, choices/options
	interpret	symbols, text, images, graphs
	explain	explicit/implicit assumptions, bias, themes/arguments, cause/effect, strengths/weaknesses
	translate	data, visual images, arguments, points of view
	assess	probabilities, choices/options
	select	main points, words, ideas in text
identify, summarise and plan	reproduce	information, data, words, images, graphics
	respond	data, visual images, arguments, points of view
	relate	events, processes, situations
	demonstrate	probabilities, choices/options
	describe	data, visual images, arguments, points of view
	plan	strategies, ideas in text, arguments
	classify	information, data, words, images
	identify	spatial relationships, patterns, interrelationships
	summarise	main points, words, ideas in text, review, draft and edit

Appendix D – Glossary of Verbs

Verbs	Definition
Analyse	Consider in detail for the purpose of finding meaning or relationships, and identifying patterns, similarities, and differences
Apply	Use, utilise or employ in a particular situation
Argue	Give reasons for or against something
Assess	Make a Judgement about the value of
Classify	Arrange into named categories in order to sort, group or identify
Compare	Estimate, measure or note how things are similar or dissimilar
Compose	The activity that occurs when students produce written, spoken, or visual texts
Contrast	Compare in such a way as to emphasise differences
Create	Bring into existence, to originate
Demonstrate	Give a practical exhibition an explanation
Describe	Give an account of characteristics or features
Discuss	Talk or write about a topic, taking into account different issues or ideas
Evaluate	Examine and judge the merit or significance of something
Examine	Determine the nature or condition of
Explain	Provide additional information that demonstrates understanding of reasoning and /or application
Extrapolate	Infer from what is known
Hypothesise	Put forward a supposition or conjecture to account for certain facts and used as a basis for further investigation by which it may be proved or disproved
Identify	Recognise and name
Interpret	Draw meaning from
Investigate	Planning, inquiry into and drawing conclusions about
Justify	Show how argument or conclusion is right or reasonable
Manipulate	Adapt or change
Plan	Strategize, develop a series of steps, processes
Predict	Suggest what might happen in the future or as a consequence of something
Reflect	The thought process by which students develop an understanding and appreciation of their own learning. This process draws on both cognitive and affective experience
Relate	Tell or report about happenings, events, or circumstances
Represent	Use words, images, symbols, or signs to convey meaning
Reproduce	Copy or make close imitation
Respond	React to a person or text
Select	Choose in preference to another or others
Sequence	Arrange in order
Summarise	Give a brief statement of the main points
Synthesise	Combine elements (information/ideas/components) into a coherent whole
Test	Examine qualities or abilities
Translate	Express in another language or form, or in simpler terms
Visualise	The ability to decode, interpret, create, question, challenge and evaluate texts that communicate with visual images as well as, or rather than, words

Appendix E – Glossary for ACT Senior Secondary Curriculum

Courses will detail what teachers are expected to teach and students are expected to learn for year 11 and 12. They will describe the knowledge, understanding and skills that students will be expected to develop for each learning area across the years of schooling.

Learning areas are broad areas of the curriculum, including English, mathematics, science, the arts, languages, health, and physical education.

A **subject** is a discrete area of study that is part of a learning area. There may be one or more subjects in a single learning area.

Frameworks are system documents for Years 11 and 12 which provide the basis for the development and accreditation of any course within a designated learning area. In addition, frameworks provide a common basis for assessment, moderation and reporting of student outcomes in courses based on the framework.

The **course** sets out the requirements for the implementation of a subject. Key elements of a course include the rationale, goals, content descriptions, assessment, and achievement standards as designated by the framework.

BSSS courses will be organised into units. A unit is a distinct focus of study within a course. A standard 1.0 unit is delivered for a minimum of 55 hours generally over one semester.

Core units are foundational units that provide students with the breadth of the subject.

Additional units are avenues of learning that cannot be provided for within the four core 1.0 standard units by an adjustment to the program of learning.

A **negotiated study unit** makes provision for students, classes, groups, or individuals to negotiate the program of learning based on the specific unit goals, content descriptions, assessment, and achievement standards of the course.

An **elective** is a lens for demonstrating the content descriptions within a standard 1.0

A **lens** is a particular focus or viewpoint within a broader study.

Content descriptions refer to the subject-based knowledge, understanding and skills to be taught and learned.

A **program of learning** is what a college develops to implement the course for a subject and to ensure that the content descriptions are taught and learned.

Achievement standards provide an indication of typical performance at five different levels (corresponding to grades A to E) following completion of study of senior secondary course content for units in a subject.

ACT senior secondary system **curriculum** comprises all BSSS approved courses of study.