Government of Western Australia
School Curriculum and Standards Authority

EARTH AND ENVIRONMENTAL SCIENCE

GENERAL COURSE

Year 11 syllabus

IMPORTANT INFORMATION

This syllabus is effective from 1 January 2015.

Users of this syllabus are responsible for checking its currency.

Syllabuses are formally reviewed by the School Curriculum and Standards Authority on a cyclical basis, typically every five years.

Content

Rationale

Science is a dynamic, collaborative and creative human endeavour arising from our desire to make sense of our world. Science knowledge is contestable and is constantly revised, refined and extended as new evidence arises. Students can experience scientific discovery and nurture their natural curiosity about the world around them.

Earth and environmental scientists integrate knowledge drawn from diverse scientific disciplines in the study of Earth's ancient and modern environments. Scientists strive to understand past and present processes so that reliable and scientifically-defensible predictions can be made about the future.

In this course, students develop their investigative, analytical and communication skills. They develop critical and creative thinking skills, and challenge themselves to identify questions and draw evidence-based conclusions using scientific methods. This development of scientific literacy enables students to investigate the natural world and the effects of human activity on our environment. They can apply these skills to their understanding of science issues in order to engage in public debate, solve problems and make evidence-based decisions about contemporary local, national and global issues. The knowledge, understanding and skills introduced in this course will provide a foundation for further studies or employment in a wide range of fields.

Aims

The Earth and Environmental Science General course aims to develop students':

- interest in earth and environmental science and their appreciation of how this multidisciplinary knowledge can be used to understand contemporary issues
- understanding of Earth as a dynamic planet consisting of interacting spheres, including the geosphere, atmosphere, hydrosphere and biosphere
- appreciation of the complex interactions that continually change Earth systems over geological timescales
- understanding of the importance of Earth resources for sustaining and enhancing quality of life
- ability to use an understanding of earth and environmental science to make balanced and informed decisions and evaluate others' decisions about sustainable practice
- ability to conduct a variety of field, research and laboratory investigations involving collection and analysis of qualitative and quantitative data, and interpretation of evidence
- ability to critically evaluate science concepts, interpretations, claims and conclusions
- ability to communicate science understandings, findings, arguments and conclusions using appropriate representations and formats.

Organisation

This course is organised into a Year 11 syllabus and a Year 12 syllabus. The cognitive complexity of the syllabus content increases from Year 11 to Year 12.

Structure of the syllabus

The Year 11 syllabus is divided into two units, each of one semester duration, which are typically delivered as a pair. The notional time for each unit is 55 class contact hours.

Unit 1 – Our changing Earth

The Earth's surface structure is continually changing, and students learn about the role of plate tectonics in the surface structure of the Earth. They examine the evidence for plate tectonics and the occurrence of volcanoes and earthquakes.

Students learn to determine the properties of minerals and to distinguish between igneous, sedimentary and metamorphic rocks based on their textural and mineralogical differences. These practical activities develop students' observation and classification skills.

Students use science inquiry skills to explore features of the Earth's surface. Fieldwork is an important part of this unit, providing valuable opportunities for students to work together to observe natural environments.

Unit 2 – Interacting Earth

Students gain an understanding of different environments as they examine local ecosystems and the effects of change on Earth's spheres, and the biogeochemical cycles that link them. They realise that changes in the atmosphere are related to changes in biodiversity.

Students use science inquiry skills to explore features of local ecosystems. Fieldwork is an important part of this unit, providing valuable opportunities for students to work together to collect first-hand data, and to observe natural environments.

Environments which can be studied include beaches, parklands, catchments, waterways, lakes, forests and bushlands, farmland and gardens. Students examine the processes and interactions occurring and analyse the impact of human activity on the environment.

Each unit includes:

- a unit description – a short description of the focus of the unit
- unit content – the content to be taught and learned.

Organisation of content

Science strand descriptions

The Earth and Environmental Science course has three interrelated strands: Science Inquiry Skills, Science as a Human Endeavour and Science Understanding. The three strands of the Earth and Environmental Science General course should be taught in an integrated way. The content descriptions for Science Inquiry Skills, Science as a Human Endeavour and Science Understanding have been written so that this integration is possible in each unit.

Science Inquiry Skills

Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting data; and communicating findings. This strand focusses on evaluating claims, investigating ideas, solving problems, reasoning, drawing valid conclusions, and developing evidence-based arguments.

Investigations can involve a range of activities, including experimental testing, field work, sample analysis, locating and using information sources, conducting surveys, and using modelling and simulations.

Science as a Human Endeavour

Science concepts, models and theories are reviewed as their predictions and explanations are continually re-assessed through new evidence, often through the application of new technologies. This review process involves a diverse range of scientists working within an increasingly global community of practice.

The application of science may provide great benefits to individuals, the community and the environment, but may also pose risks and have unintended consequences. As an ever-evolving body of knowledge, science frequently informs public debate, but is not always able to provide definitive answers.

Science Understanding

Science understanding is evident when a person selects and integrates appropriate science concepts, models and theories to explain and predict phenomena, and applies those concepts, models and theories to new situations.

The Science Understanding content in each unit develops students' understanding of the key concepts, models and theories that underpin the subject, and of the strengths and limitations of different models and theories for explaining and predicting complex phenomena.

Safety

Science learning experiences may involve the use of potentially hazardous substances and/or hazardous equipment. It is the responsibility of the school to ensure that duty of care is exercised in relation to the health and safety of all students and that school practices meet the requirements of the *Work Health and Safety Act 2011*, in addition to relevant state or territory health and safety guidelines.

Animal ethics

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

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

The Animal Welfare Act 2002 can be found at www.slp.wa.gov.au. The related animal welfare regulations, along with the licences required for the use and supply of animals, can be downloaded from www.dlg.wa.gov.au

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

Mathematical skills expected of students studying the Earth and Environmental Science General course

The Earth and Environmental Science General course requires students to use the mathematical skills they have developed through the Year 7–10 Mathematics curriculum, in addition to the numeracy skills they have developed through the Science Inquiry Skills strand of the Science curriculum.

Within the Science Inquiry Skills strand, students are required to gather, represent and analyse numerical data to identify the evidence that forms the basis of their scientific arguments, claims or conclusions. In gathering and recording numerical data, students are required to make measurements using appropriate units to an appropriate degree of accuracy.

It is assumed that students will be able to:

- perform calculations involving addition, subtraction, multiplication and division of quantities
- perform approximate evaluations of numerical expressions
- express fractions as percentages, and percentages as fractions
- calculate percentages
- translate information between graphical and numerical forms
- distinguish between discrete and continuous data and then select appropriate forms, variables and scales for constructing graphs
- construct and interpret tables and graphs
- describe and compare data sets using mean.

Progression from the Year 7–10 curriculum

This syllabus continues to develop student understanding and skills from across the three strands of the Year 7–10 Science curriculum. In the Science Understanding strand, the course draws on knowledge and understanding from across the four sub-strands of Biological, Physical, Chemical, and Earth and Space Sciences.

In particular, the course continues to develop the key concepts introduced in the Biological Sciences and Earth and Space Sciences sub-strands, that is, that a diverse range of living things has evolved on Earth over hundreds of millions of years; that living things are interdependent and interact with each other and with their environment; and that the Earth is subject to change within and on its surface, over a range of timescales as a result of natural processes and human use of resources.

Representation of the general capabilities

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

Literacy

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

Numeracy

Numeracy is vital to students' ability to apply a wide range of Science Inquiry Skills, including making and recording observations; ordering, representing and analysing data; and interpreting trends and relationships. They employ numeracy skills to interpret spatial and graphic representations, and to appreciate the ways in which Earth systems are structured, interact and change.

Information and communication technology capability

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

Critical and creative thinking

Critical and creative thinking is particularly important in the science inquiry process. Science inquiry requires the ability to construct, review and revise questions and hypotheses and to design related investigation methods. Students interpret and evaluate data; select evidence; and analyse processes, interpretations, conclusions and claims for validity and reliability. Science is a creative endeavour and students devise innovative solutions to problems, predict possibilities, envisage consequences and speculate on possible outcomes. They also appreciate the importance of critique and review in the development and innovative application of science.

Personal and social capability

Personal and social capability is integral to a wide range of activities in the Earth and Environmental Science General course, as students develop and practise skills of communication, teamwork, decision-making, initiative-taking and self-discipline with increasing confidence and sophistication. In particular, students

develop skills in both independent and collaborative investigation; they employ self-management skills to plan effectively, follow procedures efficiently and work safely; and they use collaboration skills to conduct investigations, share research and discuss ideas. In considering aspects of Science as a Human Endeavour, students also recognise the role of their own beliefs and attitudes in their response to science issues and applications, consider the perspectives of others, and gauge how science can affect people's lives.

Ethical understanding

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

Intercultural understanding

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

Representation of the cross-curriculum priorities

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

Aboriginal and Torres Strait Islander histories and cultures

Contexts that draw on Aboriginal and Torres Strait Islander histories and cultures could provide an opportunity for students to investigate the importance of Aboriginal and Torres Strait Islander Peoples' knowledge in developing a richer understanding of the Australian environment. Students could develop an appreciation of the unique Australian biota and its interactions, the impacts of Aboriginal and Torres Strait Islander Peoples on their environments and the ways in which the Australian landscape has changed over tens of thousands of years. They could examine the ways in which Aboriginal and Torres Strait Islander knowledge of ecosystems has developed over time and the spiritual significance of Country/Place, and their relationship with life-forms through totemic connections.

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. The Asia region plays an important role in scientific research and development, including through collaboration with Australian scientists, in such areas as natural hazard prediction and management, natural resource management, energy security and food security.

Sustainability

The Sustainability priority is explicitly addressed in the Earth and Environmental Science General course. The curriculum requires students to understand the interconnectedness of Earth's biosphere, geosphere, hydrosphere and atmosphere and how these systems operate and interact. Relationships, including cycles, and cause and effect are explored, and students develop skills of observation and analysis to examine these relationships in the world around them now and into the future.

Students appreciate that earth and environmental science provides the basis for decision-making in many areas of society and that these decisions can impact on the Earth system, its environments and its resources. They understand the importance of using science to predict possible effects of human and other activity, and to develop management plans, or alternative technologies, that minimise these effects and provide for a more sustainable future.

Unit 1 – Our changing Earth

Unit description

The Earth's surface structure is continually changing, and students learn about the role of plate tectonics in the surface structure of the Earth. They examine the evidence for plate tectonics and the occurrence of volcanoes and earthquakes.

Students learn to determine the properties of minerals and to distinguish between igneous, sedimentary and metamorphic rocks based on their textural and mineralogical differences. These practical activities develop students' observation and classification skills.

Students use science inquiry skills to explore features of the Earth's surface. Fieldwork is an important part of this unit, providing valuable opportunities for students to work together to observe natural environments.

Unit content

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

Science Inquiry Skills

- follow sets of written or verbal instruction accurately
- construct questions for investigation, propose hypotheses, identify variables and predict possible outcomes
- plan, select and use appropriate investigation methods, including field work, sampling techniques, laboratory experimentation and control variables to collect reliable data
- assess risk and address ethical issues associated with these methods
- organise and clearly represent data in tables and graphs to identify trends, patterns and relationships
- describe sources of experimental error
- use evidence to make and justify conclusions
- interpret a range of texts, and evaluate the conclusions by considering the quality of available evidence
- use appropriate representations, including classification keys, tables, diagrams, maps and images to communicate understanding, solve problems and make predictions
- communicate scientific ideas and information for a particular purpose, using appropriate scientific language, conventions and representations

Science as a Human Endeavour

- Earth's resources have played an important role in the development of human society and technology. Different historical periods are characterised by the use of different resources. The Stone Age employed non-metallic resources, such as flint, bone and ochre, while the Bronze Age depended on the smelting of copper to produce bronze when alloyed with tin. The Iron Age required the production of higher temperature technologies to extract iron from its ore. These resources enabled different types of artefacts to be created

Science Understanding

- the structure of the Earth – inner and outer core, mantle, lithosphere – and its position in the solar system
- ways in which plate tectonics have changed the distribution of features of the Earth's surface
- the occurrence of earthquakes and volcanic activity are related to plate boundaries
- plant, animal and geological evidence shows that super continents were assembled and broke up over geological time
- a mineral is a naturally occurring solid with its own chemical composition and crystalline structure
- mineral properties can be determined by practical investigation, including colour, streak, lustre, transparency, hardness (Mohs scale)
- rocks may be composed of several different minerals
- the rock cycle and its major processes, including plate tectonics and the water cycle, are involved in producing the three major rock types
- rocks can be classified as igneous, sedimentary or metamorphic, based on mineralogical and textural differences in physical samples, diagrams and photographs; common examples of each rock type
- the texture of sedimentary rocks, including grain size, sorting and rounding, is related to their environment of deposition
- weathering and deposition of sediments has a role in the formation of soils
- soils have different properties according to the conditions they are subjected to and their parent rock; for example, permeability, nutrients, pH, wettability, electrical conductivity

Unit 2 – Interacting Earth

Unit description

Students gain an understanding of different environments as they examine local ecosystems, the effects of change on Earth's spheres, and the biogeochemical cycles that link them. They recognise that changes in the atmosphere are related to changes in biodiversity.

Students use science inquiry skills to explore features of local ecosystems. Fieldwork is an important part of this unit, providing valuable opportunities for students to work together to collect first-hand data, and to observe natural environments.

Environments which can be studied include beaches, parklands, catchments, waterways, lakes, forests and bushlands, farmland and gardens. Students examine the processes and interactions occurring, and analyse the impact of human activity on the environment.

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Science as a Human Endeavour

- areas of local biodiversity can be affected by human impact
- Western Australia draws its water from catchments, groundwater and desalination plants
- Western Australia contains ecosystems which have World Heritage listing (Shark Bay) or classification as a globally recognised biodiversity hot spot (the southwest of Western Australia)

- the Mars mission and the search for life involves investigation of the possibility of water and carbon dioxide on Mars

Science Understanding

- composition of the atmosphere on Earth and other celestial bodies; the evolution of the atmosphere is related to changes in biodiversity
- the requirements of living things and their relationships to the biotic and abiotic aspects of the environment, including habitat, nutrition, water, temperature
- ecology, ecosystem, biodiversity, sustainable ecosystem
- a sustainable ecosystem maintains its life support systems. Sustainability of an ecosystem can be affected by natural and human factors
- organisms have developed different adaptations to their environments, resulting in biodiversity
- matter, including carbon, nitrogen and water, moves between reservoirs in the Earth, in oceans and other water reservoirs, in the atmosphere, and within and among organisms as part of biogeochemical cycles; the movement of matter between reservoirs is driven by Earth's internal and external sources of energy
- respiration and photosynthesis are important processes in the carbon cycle
- water is an important resource that undergoes constant changes of state and location during the water cycle, and is present in oceans, ice, lakes, rivers, groundwater, and in the atmosphere
- water quality and availability are dependent upon the Earth materials through which it moves and the impact of human activities, such as extraction of water, land clearing and use of fertilisers
- changes in land use are linked to environmental changes, such as salinity, eutrophication, soil degradation and nutrient depletion

School-based assessment

The Western Australian Certificate of Education (WACE) Manual contains essential information on principles, policies and procedures for school-based assessment that needs to be read in conjunction with this syllabus.

Teachers design school-based assessment tasks to meet the needs of students. The table below provides details of the assessment types for the Earth and Environmental Science General Year 11 syllabus and the weighting for each assessment type.

Assessment table – Year 11

Type of assessment	Weighting
Investigation Investigations are practical tasks or exercises designed to develop and assess a range of practical skills, conceptual understanding, and skills associated with processing data. Investigations can be communicated in any appropriate format, including written, oral or graphic. Tasks can take the form of: a practical skills exercise; design and/or conduct of an investigation; a laboratory report; analysis of second-hand data; a descriptive field study; or a short in-class test to validate the knowledge gained during the investigation.	40%
Extended task Tasks can take the form of: individual research assignments involving interpretation of a range of scientific and media texts; case studies; responses to discussions, presentations and questions; multimedia presentations. Appropriate strategies should be used to authenticate student achievement that has been completed as a part of a group or as an out-of-class task.	20%
Test Tasks can involve comprehension and interpretation exercises; analysis and evaluation of qualitative and quantitative information; application of scientific principles to explain situations; use of reasoning to construct scientific arguments, and problem solving. This assessment type is conducted in a supervised classroom setting.	40%

Teachers are required to use the assessment table to develop an assessment outline for the pair of units (or for a single unit where only one is being studied).

The assessment outline must:

- include a set of assessment tasks
- include a general description of each task
- indicate the unit content to be assessed
- indicate a weighting for each task and each assessment type
- include the approximate timing of each task (for example, the week the task is conducted, or the issue and submission dates for an extended task).

In the assessment outline for the pair of units, each assessment type must be included at least twice. In the assessment outline where a single unit is being studied, each assessment type must be included at least once.

The set of assessment tasks must provide a representative sampling of the content for Unit 1 and Unit 2.

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

Grading

Schools report student achievement in terms of the following grades:

Grade	Interpretation
A	Excellent achievement
B	High achievement
C	Satisfactory achievement
D	Limited achievement
E	Very low achievement

The teacher prepares a ranked list and assigns the student a grade for the pair of units (or for a unit where only one unit is being studied). The grade is based on the student's overall performance as judged by reference to a set of pre-determined standards. These standards are defined by grade descriptions and annotated work samples. The grade descriptions for the Earth and Environmental Science General Year 11 syllabus are provided in Appendix 1. They can also be accessed, together with annotated work samples, through the Guide to Grades link on the course page of the Authority website at www.scsa.wa.edu.au

To be assigned a grade, a student must have had the opportunity to complete the education program, including the assessment program (unless the school accepts that there are exceptional and justifiable circumstances).

Refer to the WACE Manual for further information about the use of a ranked list in the process of assigning grades.

Appendix 1 – Grade descriptions Year 11

A	**Understanding and applying concepts** Applies models and principles to explain cycles, systems and processes. Presents clear and logical arguments which are supported by evidence. Selects scientific information to support a point of view. Explains concepts using appropriate scientific language and clearly labelled diagrams.
	Science inquiry skills Formulates a testable hypothesis that states the relationship between dependent and independent variables. Plans an investigation to collect appropriate data. Identifies controlled variables and provides specific detail on how they will be controlled, e.g. each jar will contain 200 mL of water. Organises data logically and presents it in a range of forms, including appropriate graphs and tables, and identifies patterns and relationships. Accurately calculates averages. Analyses experimental data to describe trends and explains these using relevant scientific concepts. Uses evidence to make and justify conclusions that relate to the hypothesis. Evaluates experimental method and makes specific relevant suggestions to improve the validity and reliability of an investigation. Communicates information and concepts logically, using correct scientific language, conventions and representations.

B	**Understanding and applying concepts** Applies models and principles to describe and partially explain cycles, systems and processes. Presents arguments or statements which are not well-supported by evidence. Selects some scientific information to support a point of view. Explains concepts using scientific language and representations.
	Science inquiry skills Formulates a testable hypothesis that includes dependent and independent variables, within a context that has been provided. Plans an investigation to collect appropriate data. Identifies some controlled variables without detail. Presents data in a range of forms, including appropriate graphs and tables to reveal patterns and relationships. Describes trends and briefly explains these using relevant scientific concepts. Uses evidence to make conclusions that relate to the hypothesis. Recognises inconsistencies in data and makes general suggestions to improve the validity and reliability of an investigation. Communicates information and concepts logically, generally using scientific language and representations. Makes some errors in the use of conventions.

C	**Understanding and applying concepts** Describes some cycles, systems and processes in a general way. Presents statements of ideas, with some development of an argument. Selects some scientific information to support a point of view but includes some irrelevant or incorrect information. Explains concepts, without detail, using some scientific language and representations.
	Science inquiry skills Predicts a general outcome for an investigation. Plans an investigation to collect appropriate data. Inconsistently identifies some controlled variables. Presents data using basic tables and graphs. Describes trends in the data and draws simple conclusions that may not be linked back to the hypothesis. Describes difficulties experienced in conducting the investigation and makes general relevant suggestions to improve the validity and reliability of an investigation. Communicates information and concepts, without detail, using some scientific language and conventions. Representations lack detail.

D	**Understanding and applying concepts** Recognises cycles, systems and processes. Develops explanations which are incomplete or contain errors. Presents statements of ideas, but with limited development of an argument. Selects inappropriate scientific information to support a point of view. Describes concepts using simple representations and everyday language. Develops responses which are often incomplete.
	Science inquiry skills Identifies the dependent variable without linking it to the independent variable. Follows a provided experimental procedure to collect data. Confuses variables. Presents data that is unclear, insufficient and lacks appropriate processing. Identifies trends in data incorrectly or overlooks trends. Offers simple conclusions that are not supported by data or are not related to the hypothesis. Identifies difficulties experienced in conducting the investigation which affect its validity and reliability. Communicates information using everyday language with frequent errors in the use of conventions. Develops responses which are often incomplete or irrelevant.

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