Government of Western Australia
School Curriculum and Standards Authority

EARTH AND ENVIRONMENTAL SCIENCE

ATAR COURSE

Year 12 syllabus

IMPORTANT INFORMATION

This syllabus is effective from 1 January 2017.

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

Earth and environmental science is a multifaceted field of inquiry that focuses on interactions between the Earth's geosphere, hydrosphere, atmosphere and biosphere, and on dynamic, interdependent relationships that have developed between these components. Earth and environmental scientists consider how these relationships produce environmental change over a variety of timescales. To do this, they integrate knowledge, concepts, models and methods drawn from geology, biology, physics and chemistry in the study of Earth's ancient and modern environments. Earth and environmental scientists strive to understand past and present processes so that reliable and scientifically-defensible predictions can be made about the future.

The Earth and Environmental Science ATAR course builds on the content in all science sub-strands of the Year 7–10 Science curriculum. In particular, the course provides students with opportunities to explore the theories and evidence that frame our understanding of Earth's origins and history; the dynamic and interdependent nature of Earth's processes, environments and resources; and the ways in which these processes, environments and resources respond to change across a range of temporal and spatial scales.

In this course, the term 'environment' encompasses terrestrial, marine and atmospheric settings and includes Earth's interior. Environments are described and characterised with a focus on systems thinking and an integrated approach rather than with a particular ecological, biological, physical or chemical focus.

Studying senior secondary science provides students with a range of skills and understandings that are valuable to a wide range of further study pathways and careers. In the Earth and Environmental Science ATAR course, students develop their investigative, analytical and communication skills. They can apply these to their understanding of science issues in order to engage in public debate, solve problems and make evidence-based decisions about contemporary issues. The knowledge, understanding and skills introduced in this course will encourage students to become confident, active citizens who can competently use diverse methods of inquiry, and will provide a foundation for further studies or employment.

Aims

The Earth and Environmental Science ATAR 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 systems, including the geosphere, atmosphere, hydrosphere and biosphere
- appreciation of the complex interactions, involving multiple parallel processes, that continually change Earth systems over a range of timescales
- understanding that earth and environmental science knowledge has developed over time; is used in a variety of contexts; and influences, and is influenced by, social, economic, cultural and ethical considerations
- 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 with reference to evidence
- 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 12 syllabus is divided into two units which are delivered as a pair. The notional time for the pair of units is 110 class contact hours.

Unit 3 – Managing Earth resources

Students examine renewable and non-renewable resources, the implications of producing these resources, and associated management approaches.

Unit 4 – Earth hazards and climate change

Students consider how Earth processes and human activity can contribute to Earth hazards, and the ways in which these hazards can be predicted and managed to reduce their impact on Earth environments.

Each unit includes:

- a unit description – a short description of the focus of the unit
- learning outcomes – a set of statements describing the learning expected as a result of studying the unit
- unit content – the content to be taught and learned.

Organisation of content

Science strand descriptions

The Science curriculum has three interrelated strands: Science Inquiry Skills, Science as a Human Endeavour and Science Understanding. These strands are used to organise the Science learning area from Foundation to Year 12. In Earth and Environmental Science, the three strands build on students' learning in the Year 7–10 Science curriculum. The three strands of the Earth and Environmental Science 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 focuses 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.

In science investigations, the collection and analysis of data to provide evidence plays a major role. This can involve collecting or extracting information and reorganising data in the form of tables, graphs, flow charts, diagrams, cross-sections and stratigraphic columns, text, keys, spreadsheets and databases.

The analysis of data to identify and select evidence, and the communication of findings, involve the selection, construction and use of specific representations, including mathematical relationships, symbols and diagrams.

Science as a Human Endeavour

Through science, we seek to improve our understanding and explanations of the natural world. The Science as a Human Endeavour strand highlights the development of science as a unique way of knowing and doing, and explores the use and influence of science in society.

As science involves the construction of explanations based on evidence, the development of science concepts, models and theories is dynamic and involves critique and uncertainty. 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 and can involve the use of international conventions and activities such as peer review.

The use and influence of science are shaped by interactions between science and a wide range of social, economic, ethical and cultural factors. 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 a result, decision-making about socio-scientific issues often involves consideration of multiple lines of evidence and a range of stakeholder needs and values. 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. Models in science can include diagrams, physical replicas, mathematical representations, word-based analogies (including laws and principles) and computer simulations. Development of models involves selection of the aspects of the system(s) to be included in the model, and thus models have inherent approximations, assumptions and limitations.

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 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 guidelines.

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 ATAR course

The Earth and Environmental Science ATAR 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
- recognise and use ratios
- transform decimal notation to power of ten notation
- substitute physical quantities into an equation using consistent units so as to calculate one quantity and check the dimensional consistency of such calculations
- solve simple algebraic equations
- comprehend and use the symbols/notations $<$, $>$, Δ, $\approx$
- translate information between graphical, numerical and algebraic forms
- distinguish between discrete and continuous data and then select appropriate forms, variables and scales for constructing graphs
- construct and interpret frequency tables and diagrams, pie charts and histograms
- describe and compare data sets using mean, median and inter-quartile range
- interpret the slope of a linear graph.

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 ATAR 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, synthesise and critically analyse information presented in a wide range of genres, modes 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 key 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 complex spatial and graphic representations, and to appreciate the ways in which Earth systems are structured, interact and change across spatial and temporal scales. They engage in analysis of data, including issues relating to reliability and probability, and they interpret and manipulate mathematical relationships to calculate and predict values.

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. Through exploration of Science as a Human Endeavour concepts, 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 about increasingly complex and abstract scenarios and to design related investigation methods. Students interpret and evaluate data; interrogate, select and cross-reference evidence; and analyse processes, interpretations, conclusions and claims for validity and reliability, including reflecting on their own processes and conclusions. Science is a creative endeavour and students devise innovative solutions to problems, predict possibilities, envisage consequences and speculate on possible outcomes as they develop Science Understanding and Science Inquiry Skills. They also appreciate the role of critical and creative individuals and the central 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 ATAR 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 evaluate the ethics of experimental science, codes of practice, and the use of scientific information and science applications. They 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

Through 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 ATAR 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 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. Students could develop an appreciation that interaction between human activity and the diverse environments of the Asia region continues to influence the region, including Australia, and has significance for the rest of the world. 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 cross-curriculum priority of Sustainability is explicitly addressed in the Earth and Environmental Science ATAR course. The curriculum requires students to understand the interconnectedness of Earth’s biosphere, geosphere, hydrosphere and atmosphere, and how these systems operate and interact across a range of spatial and temporal scales. 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 the Earth and Environmental Science ATAR course 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 3 – Managing Earth resources

Unit description

Earth resources are required to sustain life and provide infrastructure for living, for example, food, shelter, medicines, transport, and communication, driving ongoing demand for mineral and energy resources and biotic resources. In this unit, students explore renewable and non-renewable resource formation and analyse the effects that resource extraction, sustainable use and associated rehabilitation processes have on Earth systems.

Students examine the occurrence of non-renewable mineral and energy resources and review how an understanding of Earth and environmental science processes guides resource exploration and extraction. They investigate how the rate of extraction is managed to sustain the quality and availability of renewable resources, including water, energy resources and biota, and the importance of monitoring and modelling to manage these resources at local, regional and global scales. Students learn about ecosystem services and how natural and anthropogenic changes of the biosphere, hydrosphere, atmosphere and geosphere influence resource availability and sustainable management.

Students investigate the ways in which science contributes to contemporary debate regarding local, regional and international resource use and action for sustainability, and recognise the limitations of science in providing definitive answers in different contexts.

Students use science inquiry skills to collect, analyse and interpret data relating to the formation, extraction, and processing of resources. They critically analyse the range of factors that determine management of renewable and non-renewable resources.

Learning outcomes

By the end of this unit, students:

- understand the difference between some renewable and non-renewable Earth resources and their formation, and how exploration for them is carried out
- understand how the extraction and processing of some resources is managed to sustain Earth systems at local, regional and global scales
- understand how models and theories have developed over time; and the ways in which Earth and environmental science knowledge interacts with social, economic, cultural and ethical considerations in a range of contexts
- use science inquiry skills to collect, analyse and communicate primary and secondary data using qualitative and quantitative representations in appropriate formats.

Unit content

An understanding of the Year 11 content is assumed knowledge for students in Year 12.

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

Science Inquiry Skills

- propose hypotheses; plan, and predict possible outcomes; and conduct investigations
- design investigations, including the procedure(s) to be followed, the information required and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics
- conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, competently and methodically for the collection of valid and reliable data
- identify and classify metamorphic rocks based on texture and mineralogy (including slate, phyllite, schist, gneiss, marble, quartzite) from physical samples, diagrams and photographs
- represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error and uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions
- interpret a range of scientific and media texts and evaluate processes, claims and conclusions by considering the quality of available evidence, use reasoning to construct scientific arguments
- select, construct and interpret appropriate representations, including maps and geological cross-sections where the section line is perpendicular to strike, and other spatial representations such as block diagrams and stratigraphic columns, to communicate conceptual understanding, solve problems and make predictions
- communicate to specific audiences and for specific purposes using appropriate language and formats, including compilations of field data and research reports

Science as a Human Endeavour

- development of coupled geological and geophysical techniques (measuring magnetic fields and electromagnetic induction) and remote sensing technologies (including aerial photography, satellite based spectroscopes) have increased the rate of identification of mineral and energy resources and improved estimates of their size and value prior to extraction
- decisions about whether to and how to extract a resource depend on the value, location and volume of the resource. Consultation and negotiation with local and indigenous communities are required to further assess the impacts on and costs to the environment and community of removing the resource
- decisions to invest in energy technologies that harness Earth's internal geothermal heat are informed by environmental, economic and political considerations
- recognition of the relatively small amounts of fresh water available for biological processes informs community decision making about investment in infrastructure and technologies to increase access to high quality water, including dams, desalination plants

Science Understanding

Non-renewable Earth resources

- non-renewable mineral and energy resources are formed over geological timescales so are not readily replenished
- the location of non-renewable mineral and energy resources, including fossil fuels, iron ore, nickel and gold, is related to their geological setting, including sedimentary, magmatic, metamorphic and hydrothermal processes
- mineral and energy resources are discovered using a variety of techniques, including mapping, satellite images, aerial photographs, geophysical and geochemical methods, to identify the spatial extent of the deposit and quality of the resource
- environmental considerations are important in the exploration, extraction and processing of non-renewable resources, and the decommissioning of resource sites
- extraction of mineral and energy resources influences interactions between the abiotic and biotic components of ecosystems, including hydrologic systems

Renewable Earth resources

- renewable resources are those that are typically replenished at timescales of years to decades and include harvestable resources (including water, biota and some energy resources) and ecosystem services
- ecosystems provide a range of renewable resources, including provisioning services (including food, water, timber), regulating services (including carbon sequestration, climate control), and supporting services (including nutrient, air and water cycling)
- the abundance of a renewable resource and how readily it can be replenished influence the rate at which it can be sustainably used at local, regional and global scales
- the cost-effective use of renewable energy resources is constrained by the efficiency of available technologies to collect, store and transfer the energy resource
- human activities affect the quality and availability of fresh water, including aquifer recharge, desalination, over-extraction, land clearing and eutrophication
- producing, harvesting, transporting and processing of resources for consumption, and assimilating the associated wastes, involves the use of resources; the concept of an 'ecological footprint' is used to measure the magnitude of this demand

Unit 4 – Earth hazards and climate change

Unit description

Earth hazards occur over a range of timescales and have significant impacts on Earth systems across a wide range of spatial scales. Investigation of naturally occurring and anthropogenic Earth hazards enables prediction of their impacts, and the development of management and mitigation strategies. In this unit, students examine the causes and effects of naturally occurring Earth hazards, including volcanic eruptions, earthquakes and tsunamis. The composition of magma is examined to predict the degree of volcanic explosivity and hence the risk of hazard that an eruption could inflict on the environment. This unit focuses on the timescales at which the effects of natural and human-induced change are apparent and the ways in which scientific data are used to provide strategic direction for the mitigation of Earth hazards and environmental management decisions.

Students review the scientific evidence for climate change models, including the examination of evidence from the geological record, oceanic and atmospheric data, and explore different interpretations of the same evidence. They consider the reliability of these models for predicting climate change, and the implications of future climate change events, including changing weather patterns, globally and in Australia, for example, changes in flooding patterns or aridity, and changes to vegetation distribution, river structure and groundwater recharge.

They investigate the ways in which science contributes to contemporary debate regarding local, regional and international management of Earth hazards, evaluation of risk and action for sustainability, and recognise the limitations of science in providing definitive answers in different contexts.

Students use inquiry skills to collect, analyse and interpret data relating to the cause and impact of Earth hazards. They critically analyse the range of factors that influence the magnitude, frequency, intensity and management of Earth hazards at local, regional and global levels.

Learning outcomes

By the end of this unit, students:

- understand the causes of Earth hazards and the ways in which they impact on, and are impacted by, Earth systems
- understand how environmental change is modelled, and how the reliability of these models influences predictions of future events and changes
- understand how models and theories have developed over time; and the ways in which Earth and environmental science knowledge interacts with social, economic, cultural and ethical considerations in a range of contexts
- use science inquiry skills to collect, analyse and communicate primary and secondary data using qualitative and quantitative representations in appropriate formats.

Unit content

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

Science Inquiry Skills

- propose hypotheses; plan, and predict possible outcomes; and conduct investigations
- design investigations, including the procedure(s) to be followed, the information required and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics
- conduct laboratory and field investigations, including using map and field location techniques and environmental sampling and identification procedures, safely, competently and methodically for the collection of valid and reliable data
- represent data in meaningful and useful ways; organise and analyse data to identify trends, patterns and relationships; qualitatively describe sources of measurement error and uncertainty and limitations in data; and select, synthesise and use evidence to make and justify conclusions
- interpret a range of scientific and media texts and evaluate processes, claims and conclusions by considering the quality of available evidence, use reasoning to construct scientific arguments
- select, construct and interpret appropriate representations, including maps and geological cross-sections where the section line is perpendicular to strike, and other spatial representations, such as block diagrams and stratigraphic columns, to communicate conceptual understanding, solve problems and make predictions
- communicate to specific audiences and for specific purposes using appropriate language and formats, including compilations of field data and research reports

Science as a Human Endeavour

- sophisticated models of the dynamics and mechanics of plate tectonic motion and collision enable prediction of future plate tectonic movements and provide data for local evidence-based decision making, for example, development of infrastructure, location of geothermal resources
- advances in knowledge and understanding of seismic processes have led to improved design of ground-shake resistant structures and identification of areas likely to be affected by earthquakes
- some ecosystems rely on episodic earth hazard events to rejuvenate and maintain their long-term viability, including flood plain fertility, bushfire and seed germination
- models for long term climatic trends are subject to debate and revision, based on the availability of supporting evidence and review of the underpinning assumptions and limitations
- studies of human impact on the atmosphere, hydrosphere and ecosystems rely on evidence from many scientific disciplines over time; these studies inform the concept of environmentally sustainable development

Science Understanding

The cause and impact of Earth hazards

- Earth hazards result from the interactions of Earth systems and can threaten life, health, property, or the environment; their occurrence may not be prevented, but their effects can be mitigated
- plate tectonic processes generate earthquakes, volcanic eruptions and tsunamis; the occurrence of these events affects other Earth processes and interactions, including the influence of volcanic emissions on climate and weather
- monitoring and analysis of data, including composition of volcanic magma, ground motion monitoring, and earthquake location and frequency data, allows the mapping of potentially hazardous zones. This contributes to the future prediction of the location and probability of repeat occurrences of hazardous Earth events, including volcanic eruptions, earthquakes and tsunamis
- the impact of natural hazards on the biosphere depends on the location, magnitude and intensity of the hazard, and the structure and composition of Earth materials influencing the hazard

The cause and impact of global climate change

- natural processes (including oceanic circulation, orbitally-induced solar radiation fluctuations, the plate tectonic supercycle) contribute to global climate changes that are evident at a variety of timescales
- human activities, particularly land-clearing and fossil fuel consumption, produce gases including carbon dioxide, methane, nitrous oxide and hydrofluorocarbons, and particulate materials, that can change the composition of the atmosphere and climatic conditions, including an enhanced greenhouse effect
- climate change affects the biosphere, atmosphere, geosphere and hydrosphere; climate change has been linked to changes in species distribution, crop productivity, sea level, rainfall patterns, surface temperature and extent of ice sheets
- geological, prehistorical and historical records provide evidence (including fossils, pollen grains, ice core data, isotopic ratios) that climate change has affected regions and species differently over time
- climate change models (including general circulation models, models of El Niño and La Niña) describe the behaviour and interactions of the oceans and atmosphere; these models are developed through the analysis of past and current climate data, with the aim of predicting the response of global climate to changes in the contributing components, including changes in global ice cover and atmospheric composition

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 ATAR Year 12 syllabus and the weighting for each assessment type.

Assessment table – Year 12

Type of assessment	Weighting
Investigation Investigations are practical tasks or exercises designed to develop and assess a range of practical skills and 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, a descriptive field study or a short in-class test to validate the knowledge gained during the investigation.	20%
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.	10%
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.	20%
Examination Typically conducted at the end of each semester and/or unit and reflecting the examination design brief for this syllabus.	50%

Teachers are required to use the assessment table to develop an assessment outline for the pair of units.

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.

The set of assessment tasks must provide a representative sampling of the content for Unit 3 and Unit 4.

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. 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 ATAR Year 12 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.

ATAR course examination

All students enrolled in the Earth and Environmental Science ATAR Year 12 course are required to sit the ATAR course examination. The examination is based on a representative sampling of the content for Unit 3 and Unit 4. Details of the ATAR course examination are prescribed in the examination design brief on the following page.

Refer to the WACE Manual for further information.

Examination design brief – Year 12

Time allowed

Reading time before commencing work: ten minutes
Working time for paper: three hours

Permissible items

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: protractor, drawing compass, mathomat; up to three calculators, which do not have the capacity to create or store programmes or text, are permitted in this ATAR course examination

Additional information

The question/answer booklet contains a blank/removable A4 page.

Section	Supporting information
Section One **Multiple-choice** 15% of the total examination 15 questions Suggested working time: 20 minutes	Nil
Section Two **Short answer** 55% of the total examination 7–10 questions Suggested working time: 100 minutes	Questions can require the candidate to refer to stimulus material, including: text, graphs, diagrams, photographs, data sets and/or scenarios.
Section Three **Extended answer** 30% of the total examination Two questions: one compulsory question and one question from a choice of two Suggested working time: 60 minutes	Questions can be in parts. Questions can require the candidate to refer to stimulus material, including: text, graphs, diagrams, photographs, data sets and/or scenarios.

Appendix 1 – Grade descriptions Year 12

Grade	Description
A	**Understanding and applying concepts** Applies models and scientific principles to comprehensively explain and link complex systems and processes. Supports responses with a range of appropriate examples and accurate diagrams. Accurately applies scientific knowledge to explain, in detail, unfamiliar contexts or examples. Selects and accurately evaluates scientific information from a variety of sources to present logical, well-developed arguments which are supported by relevant, detailed evidence. Interprets information to describe complex relationships using appropriate terminology and conventions.
	Science inquiry skills Consistently formulates a testable hypothesis that states the relationship between dependent and independent variables. Plans and conducts investigations, identifying appropriate variables and explaining how they are controlled; describes the experimental method in detail and accurately collects data. Processes data accurately and presents it logically in a range of forms, including graphs, tables and diagrams to identify patterns and relationships. Comprehensively explains trends using numerical data, where appropriate, and uses evidence to draw conclusions that support or refute the hypothesis. Evaluates the experimental method and provides specific relevant suggestions to improve the quality of the data collected. Communicates detailed information and concepts logically and coherently, using appropriate terminology and conventions.

Grade	Description
B	**Understanding and applying concepts** Applies models and scientific principles to accurately explain and link simple, and some complex, systems and processes. Supports responses with appropriate examples and accurate diagrams. Applies scientific knowledge to explain unfamiliar contexts or examples, sometimes omitting detail. Selects and evaluates scientific information from a variety of sources to present logical arguments which are supported by relevant evidence. Interprets information to describe relationships using appropriate terminology and conventions.
	Science inquiry skills Usually formulates a testable hypothesis that states the relationship between dependent and independent variables. Plans and conducts investigations, identifying and controlling appropriate variables; describes the experimental method and accurately collects data. Processes most data accurately and presents it logically in a range of forms including graphs, tables and diagrams to identify patterns and relationships. Explains trends using some numerical data, where appropriate, and uses evidence to draw conclusions that support or refute the hypothesis. Evaluates the experimental method and provides relevant suggestions to improve the quality of the data collected. Communicates information and concepts logically, using appropriate terminology and conventions.

Grade	Description
C	**Understanding and applying concepts** Applies models and scientific principles to describe simple systems and processes. Provides examples in some responses and draws diagrams that may contain minor inaccuracies or omissions. Provides responses to unfamiliar contexts which are generic and may lack specific application of scientific knowledge. Selects some scientific information to provide general arguments or statements supported by some evidence. Interprets information to describe simple relationships, using appropriate terminology and conventions.
	Science inquiry skills Formulates a testable hypothesis that links dependent and independent variables. Plans and conducts investigations identifying and controlling some variables; briefly outlines the experimental method and collects data. Processes data with some errors or omissions. Presents data using basic tables and diagrams and appropriate graphs. Describes trends in data and draws simple conclusions that may not be linked back to the hypothesis. Provides general suggestions to improve the investigation. Communicates information and concepts without detail, using some appropriate terminology and conventions.
D	**Understanding and applying concepts** Applies some scientific concepts correctly to describe systems and processes. Provides poor examples, or omits examples, and draws diagrams which are incomplete or incorrect. Inconsistently applies scientific knowledge to familiar and unfamiliar contexts. Presents statements of ideas with limited development of an argument and limited supporting evidence. Provides responses that may lack detail and include irrelevant information. Interprets information to inaccurately describe relationships using everyday language.
	Science inquiry skills Identifies one or more relevant variables without making links between them. Identifies a limited number of controlled variables. Does not distinguish between the dependent, independent and controlled variables. Describes an experimental method which lacks detail. Presents data that is unclear, insufficient and lacks appropriate processing. Identifies trends in data incorrectly or overlooks trends. Provides simple conclusions that are not always supported by the data or are not related to the hypothesis. Provides suggestions that may not improve the investigation. Communicates information using everyday language with some errors in the use of conventions.
E	Does not meet the requirements of a D grade and/or has completed insufficient assessment tasks to be assigned a higher grade.