



Government of **Western Australia**  
School Curriculum and Standards Authority

# INTEGRATED SCIENCE

ATAR COURSE

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Year 12 syllabus

## **IMPORTANT INFORMATION**

This syllabus is effective from 1 January 2020.

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.

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# Content

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<b>Rationale</b> .....	<b>1</b>
<b>Course outcomes</b> .....	<b>2</b>
<b>Organisation</b> .....	<b>3</b>
Structure of the syllabus .....	3
Organisation of content .....	3
Representation of the general capabilities .....	6
Representation of the cross-curriculum priorities .....	7
<b>Unit 3 – Water</b> .....	<b>9</b>
Unit description .....	9
Unit content .....	9
<b>Unit 4 – Energy</b> .....	<b>12</b>
Unit description .....	12
Unit content .....	12
<b>School-based assessment</b> .....	<b>15</b>
Grading .....	16
<b>ATAR course examination</b> .....	<b>17</b>
Examination design brief – Year 12 .....	17
<b>Appendix 1 – Grade descriptions Year 12</b> .....	<b>18</b>
<b>Appendix 2 – Glossary</b> .....	<b>20</b>



## Rationale

Science is a dynamic, collaborative human activity that uses distinctive ways of valuing, thinking and working to understand natural phenomena. Science is based on people's aspirations and motivations to follow their curiosity and wonder about the physical, biological and technological world. Scientific knowledge represents the constructions made by people endeavouring to explain their observations of the world around them. Scientific explanations are built in different ways as people pursue intuitive and imaginative ideas, respond in a rational way to hunches, guesses and chance events, challenge attitudes of the time, and generate a range of solutions to problems, building on existing scientific knowledge. As a result of these endeavours, people can use their scientific understandings with confidence in their daily lives. Scientific explanations are open to scrutiny; scientific knowledge may be tentative and is continually refined in the light of new evidence.

The Integrated Science ATAR course encourages students to be questioning, reflective and critical thinkers about scientific issues. The course is based on an integrated view of scientific knowledge that draws on the traditional disciplines of science and new scientific technology to enable students to investigate issues that are interesting and relevant in a modern world. This course provides opportunities for students to consider contemporary scientific developments. This process enables them to make informed judgements and decisions about questions that directly affect their lives and the lives of others.

The course is grounded in the belief that science is, in essence, a practical activity. From this stems the view that conceptual understandings in science derive from a need to find solutions to real problems in the first instance. The inquiring scientist may then take these understandings and apply them in a new context, often quite removed from their original field. This course seeks to reflect this creative element of science as inquiry. It should involve students in research that develops a variety of skills, including the use of appropriate technology, an array of diverse methods of investigation and a sense of the practical application of the domain. It emphasises formulating and testing hypotheses and the critical importance of evidence in forming conclusions. This course enables students to investigate science issues, in the context of the world around them, and encourages student collaboration and cooperation with community members employed in scientific pursuits. It requires them to be creative, intellectually honest, to evaluate arguments with scepticism and to conduct their investigations in ways that are ethical, fair and respectful of others.

The Integrated Science ATAR course is inclusive and aims to be attractive to students with a wide variety of backgrounds, interests and career aspirations. The course will equip students to undertake tertiary study and/or gain employment.

## Course outcomes

The Integrated Science ATAR course is designed to facilitate achievement of the following outcomes.

### Outcome 1 – Science Inquiry Skills

Students investigate, to answer questions about the natural and technological world, using reflection and analysis to prepare a plan; collect, process and interpret data; communicate conclusions; and evaluate their plan, procedures and findings.

In achieving this outcome, students:

- plan investigations to test ideas about the natural and technological world
- collect and record a variety of information relevant to their investigations
- translate and analyse information to find patterns and draw conclusions to extend their understanding
- reflect on an investigation, evaluate the process and generate further ideas.

### Outcome 2 – Science as a Human Endeavour

Students understand that science is a human activity involving the application of scientific knowledge to solve problems and make informed decisions that impact on people and the environment.

In achieving this outcome, students:

- understand the evolving nature of science
- understand that scientific knowledge can be applied to solve problems
- understand that scientific evidence informs decisions that impact on people and the environment.

### Outcome 3 – Science Understanding

Students understand relationships within and between living and physical systems by integrating concepts of energy and the structure and nature of matter.

In achieving this outcome, students:

- understand the nature of matter and its relationship to structures in living and physical systems
- understand interactions between components in living and physical systems
- understand interactions between energy and matter.

## 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 – Water

Through an integrated, scientific approach, this unit focuses on water as a resource and its importance to life on Earth.

#### Unit 4 – Energy

This unit focuses on energy, energy uses, energy production and sustainability of energy resources, through an integrated scientific approach.

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 Integrated Science ATAR course has three interrelated strands: Science Inquiry Skills, Science as a Human Endeavour and Science Understanding, which build on students' learning in the Year 7–10 Science curriculum. The three strands of Science 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 is concerned with evaluating claims, investigating ideas, solving problems, reasoning, drawing valid conclusions, and developing evidence-based arguments.

Science investigations are activities in which ideas, predictions or hypotheses are tested and conclusions are drawn in response to a question or problem. Investigations can involve a range of activities, including experimental testing, field work, locating and using information sources, conducting surveys, and using modelling and simulations.

In science investigations, the collection and analysis of data to provide evidence play a major role. This can involve collecting or extracting information and reorganising data in the form of tables, graphs, flow charts, diagrams, text, keys, spread sheets 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.

Through the Integrated Science ATAR course, students will continue to develop their science inquiry skills, building on the skills acquired in the Year 7–10 Science curriculum. Each unit provides specific skills to be taught. These specific skills align with the Science Understanding and Science as a Human Endeavour content of the unit.

### **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 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](http://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*.

The *Animal Welfare Act 2002* can be found at [www.slp.wa.gov.au](http://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](http://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/](http://www.det.wa.edu.au/curriculumsupport/animalethics/detcms/portal/).

## Mathematical skills expected of students studying the Integrated Science ATAR course

The Integrated 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 Year 7–10 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 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.

Students may need to be taught when it is appropriate to join points on a graph and when it is appropriate to use a line of best fit. They may also need to be taught how to construct a straight line that will serve as the line of best fit for a set of data presented graphically.

It is assumed that students will be able to competently:

- 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
- comprehend and use the symbols/notations  $<$ ,  $>$ ,  $\Delta$ ,  $\approx$
- 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 Integrated 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 biological and physical 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 concept, 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 Integrated Science ATAR course. 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, analyse critically 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

Intercultural understanding is fundamental to understanding aspects of Science as a Human Endeavour, as 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 demonstrate 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 Integrated 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 opportunities for students to recognise 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 Peoples' knowledge of ecosystems has developed over time, and the spiritual significance of Country/Place.

## **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 explore the diverse environments of the Asia region and develop an appreciation that interaction between human activity and these environments continues to influence the region, including Australia, and has significance for the rest of the world. By examining developments in science and technology, students could appreciate that the Asia region plays an important role in scientific research and development through collaboration with Australian scientists.

## **Sustainability**

The Sustainability cross-curriculum priority is explicitly addressed in the Integrated Science ATAR course. This course provides authentic contexts for exploring, investigating and understanding the function and interactions of biotic and abiotic systems across a range of spatial and temporal scales. By investigating the relationships between biological systems and system components, and how systems respond to change, students develop an appreciation for the interconnectedness of the environmental, social and economic factors associated within the biosphere. Students appreciate that integrated science provides the basis for decision making in many areas of society and that these decisions can impact the Earth system. They understand the importance of using science to predict possible effects of human activities, and to develop management plans or alternative technologies that minimise these effects and provide for a more sustainable future.

## Unit 3 – Water

### Unit description

Water provides the Earth with the capacity of supporting life. Two-thirds of the Earth's surface is covered with water, which provides habitats for aquatic organisms, as well as valuable resources to support human activities.

There is a wide variety of aquatic ecosystems ranging from salt water in the open ocean, coastal, estuarine ecosystems to fresh water ecosystems in surface catchments and ground water aquifers. Aquatic ecosystems are important to the Australian environment, society and economy. Increasing human populations are placing demands for resources and development that pose threats to our aquatic ecosystems. Research on the ecology of habitats is an important scientific area that allows scientists to monitor changes in ecosystems and implement best management practice.

Students investigate how water resources are under threat from pollution, over-use and a changing global climate. They explore the use of current water resources, and the development of other non-conventional water resources, to safeguard that there is sufficient water available for future generations.

This unit increases students' scientific understanding of the importance of management practices to maintain biodiversity in aquatic ecosystems and adequate water resources.

### 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

- identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
- design investigations, including the procedure(s) to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics
- conduct investigations, including testing and monitoring water quality and sampling of aquatic macro-invertebrates, 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; and use reasoning to construct scientific arguments
- select, construct and use appropriate representations, including labelled diagrams and models, to communicate conceptual understanding, solve problems and make predictions
- select, use and interpret appropriate mathematical representations, including linear and non-linear graphs, to solve problems and make predictions

- communicate to specific audiences, and for specific purposes, using appropriate language, nomenclature, genres and modes, including scientific reports

### Science as a Human Endeavour

- aquatic environments provide essential ecosystem services which are used by humans for economic and social benefits
- impact of human activities on the public drinking water supply and quality
- strategies used to ensure water resources and quality are maintained involve reducing consumption and the development of new technologies, including desalination and managed aquifer recharge
- monitoring of water resources and analysis and interpretation of data is used to make informed decisions related to land use in catchment areas and preservation of natural waterways to safeguard sufficient drinking water supply

### Science Understanding

#### Importance of water

- the water cycle has a central role in sustaining life on Earth through the supply of fresh water; this is being affected by changing rainfall patterns
- water occurs naturally in three states (solid, liquid, gas) of matter on the Earth's surface and each has a significant role in regulating Earth's climate

#### Aquatic ecosystems

- the polarity of water molecules helps to explain its properties of high surface tension, high specific heat and density
- buoyancy is affected by differences in water density and temperature
- diversity and abundance of aquatic life is affected by the physical and chemical conditions of water, including
  - salt concentration
  - nutrients – phosphates and nitrates
  - dissolved oxygen
  - turbidity
  - pH
  - temperature
- solubility of salts, nutrients and gases can be affected by temperature, pressure and concentration gradient
- exchange of gases between water and aquatic organisms is affected by surface area to volume ratio, the nature of its exchange membrane, and maintaining the concentration gradient
- marine and freshwater fish use different mechanisms for osmoregulation
- the high specific heat capacity of water helps regulate a stable temperature for the atmosphere and aquatic environments, thus affects internal temperatures of aquatic organisms

- use the equation  $Q = mc\Delta T$  to calculate the specific heat of water
- macro-invertebrate monitoring in aquatic ecosystems can be conducted using a variety of methods to sample known volumes of water
- producers and consumers have an important role in the flow of energy and the cycling of matter in aquatic ecosystems; these interactions can be represented using food webs, biomass and energy pyramids
- biomagnification, eutrophication and oil pollution, affect the ecology of aquatic ecosystems

**Water resources and sustainability**

- the main potable water resources for Western Australia are surface water, ground water and desalinated water
- availability and distribution of potable water resources in Western Australia is affected by changing rainfall patterns
- management strategies of catchment areas are utilised to prevent dry land salinity, eutrophication and erosion
- treatment of domestic wastewater is required before return of the water to the environment

## Unit 4 – Energy

### Unit description

Students live in a modern society that is characterised by its reliance upon technology and high demands for energy. As a consequence, we are faced with a number of significant and global challenges: the enhanced greenhouse effect, climate change, resource availability and need to consider the efficient use of energy, and the development of alternative energy resources. Studies based on this crucial area will enable students to develop an awareness of the finite nature of non-renewable energy resources, and a concern for the implications for individuals and their communities. Students develop an appreciation of the consequences of harnessing, distributing and utilising energy, which will enable them to be informed citizens and develop personal, defensible positions with respect to these issues.

Through the investigation of appropriate contexts, students explore how international collaboration, evidence from multiple disciplines, and the use of ICT and other technologies, have contributed to developing understanding of energy use and electricity production. They investigate how scientific knowledge is used to offer valid explanations and reliable predictions, and the ways in which scientific knowledge interacts with economic and ethical factors.

Students use science inquiry skills to explore the methods of transfer and transformation of energy for use in our everyday lives. Students consider the effect of a changing population, and the finite nature of fossil fuels as a source of energy, on the production of electricity and its use in our lives. They develop skills in constructing and using models and flow diagrams to describe and interpret data about energy transformation and energy efficiency.

This unit involves students in a detailed study of energy, resources, alternatives, and the outcomes of continuing reliance on fossil fuels. Throughout the course of this unit, students are encouraged to make informed opinions about energy generation, distribution and use.

### Unit content

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

#### Science Inquiry Skills

- identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes
- design investigations, including the procedure/s to be followed, the materials required, and the type and amount of primary and/or secondary data to be collected; conduct risk assessments; and consider research ethics, including animal ethics
- conduct investigations 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; and use reasoning to construct scientific arguments
- select, use and interpret appropriate mathematical representations, including linear and non-linear graphs and algebraic relationships representing physical systems, to solve problems and make predictions
- select, construct and use appropriate representations, including labelling diagrams and using models, to communicate conceptual understanding, solve problems and make predictions
- communicate to specific audiences and for specific purposes using appropriate language, nomenclature, genres and modes, including scientific reports

### Science as a Human Endeavour

- the increased demand on energy and the finite nature of resources have resulted in development of new techniques of extraction which have consequences on the environment and society
- developments in engine design to use alternative fuels, including electric motors and hydrogen fuel cells, are reducing the impact on the environment and extending energy resource lifetimes
- disposal of radioactive material in geologic storage requires long-term management
- international agreements on the need to reduce greenhouse gas emissions have encouraged the development of new technologies
- decisions to invest in technologies that harness renewable energy resources are informed by environmental, economic and political considerations
- the various methods of electricity production have advantages and disadvantages related to efficiency, cost, base load supply, and environmental, economic and social impact

### Science Understanding

#### Energy

- forms of energy are potential (chemical, elastic, gravitational, nuclear), kinetic (mechanical, heat, electrical, sound) and light energy
- work is done when energy is transformed or transferred within a system
- the Law of Conservation of Energy states that energy can neither be created nor destroyed but can be transferred or transformed

#### Sources of energy

- energy from the Sun was converted in the past into the non-renewable resources of fossil energy and can be converted now into renewable resources of biomass, biofuels, hydropower, wind and solar energy
- geothermal and nuclear are alternative sources of energy

## Electricity

- generation of electrical current is achieved through
  - electromagnetic induction in generators
  - electrochemistry in batteries
  - photovoltaic effect in solar cells
- conventional large-scale electricity generation occurs in power stations that are fuelled by coal or gas
- electricity generation can be produced using nuclear fission, in pressurised water reactors
- the transformation of electrical energy can result in lighting, heating, cooling and communication for use in the home

## Transportation

- the structure and function of the internal combustion engine takes advantage of energy transformations to generate motion

## Heating

- heat is the transfer of energy, which can occur by convection, conduction, radiation and evaporation
- heating of the home is achieved by
  - burning of wood and fossil fuels, and the consumption of electricity for direct heating
  - passive solar design takes advantage of radiant heat to warm the home

## Environmental and societal issues

- electricity generation impacts on society and the environment through
  - resource extraction disturbing natural ecosystems
  - land clearing for infrastructure
  - emissions which contribute to the enhanced greenhouse effect
  - production of wastes, including nuclear
  - consumption and pollution of water
- the extraction of shale gas by hydraulic fracturing (fracking), is increasing resource lifetimes
- effects of radiation on the human body can include nausea and vomiting and changes to deoxyribonucleic acid (DNA), which can lead to cancers, cell death and burns
- protective measures are required to safeguard against dangerous exposure to radioactive substances
- energy consumption in the home can be reduced by using energy efficient appliances
- energy efficiency can be determined mathematically using:

$$\text{efficiency} = \frac{\text{energy out}}{\text{energy in}} \times 100$$

- the power consumed by appliances can be calculated by the mathematical formula of :

$$P = \frac{E}{t}$$

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

### Assessment table – Year 12

Type of assessment	Weighting
<p><b>Science inquiry</b></p> <p>Science inquiry involves identifying and posing questions; planning, conducting and reflecting on investigations; processing, analysing and interpreting data; and communicating findings. Students evaluate claims, investigate ideas, solve problems, reason, draw valid conclusions, and/or develop evidence-based arguments.</p> <p>Students must complete at least one investigation over the pair of units.</p> <p><b>Practical</b></p> <p>Practical work can involve a range of activities, such as practical tests; modelling and simulations; qualitative and/or quantitative analysis of second-hand data; and/or brief summaries of practical activities.</p> <p><b>Investigation</b></p> <p>Investigations are more extensive activities, which can include experimental testing; conducting surveys; and/or comprehensive scientific reports.</p>	25%
<p><b>Extended response</b></p> <p>Tasks requiring an extended response can involve selecting and integrating appropriate science concepts, models and theories to explain and predict phenomena, and applying those concepts, models and theories to new situations; interpreting scientific and/or media texts and evaluating processes, claims and conclusions by considering the quality of available evidence; and using reasoning to construct scientific arguments.</p> <p>Assessment can take the form of answers to specific questions based on individual research; exercises requiring analysis; and interpretation and evaluation of information in scientific journals, media texts and/or advertising.</p>	10%
<p><b>Test</b></p> <p>Tests typically consist of multiple-choice questions and questions requiring short and extended answers. Tests should be designed so that students can apply their understanding and skills in Integrated Science to analyse, interpret, solve problems and construct scientific arguments.</p>	25%
<p><b>Examination</b></p> <p>Typically conducted at the end of each semester and/or unit, and reflecting the examination design brief for this syllabus.</p>	40%

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.

Appropriate strategies should be used to authenticate student achievement for tasks that have been completed out of class or as part of a group.

## 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 Integrated 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](http://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 Integrated 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: up to three calculators, which do not have the capacity to create or store programmes or text, are permitted in this ATAR course examination

SECTION	SUPPORTING INFORMATION
<b>Section One</b> <b>Multiple-choice</b> 20% of the total examination 20 questions Suggested working time: 30 minutes	Questions can require the candidate to refer to the stimulus material that can include: text, diagrams, second-hand data and/or graphs.
<b>Section Two</b> <b>Short response</b> 50% of the total examination 4–6 questions Suggested working time: 90 minutes	Questions can require the candidate to refer to the stimulus material that can include: text, diagrams, graphs, second-hand data and/or recent research material.  The candidate's responses can include: worked calculations, labelled diagrams with explanatory notes; lists of points with linking sentences; labelled tables and/or graphs; and annotated flow diagrams with introductory notes.
<b>Section Three</b> <b>Extended response</b> 30% of the total examination Two questions Suggested working time: 60 minutes	Questions can require the candidate to refer to the stimulus material that can include: text, diagrams, graphs, second-hand data and/or recent research findings.  The candidate's responses can include worked calculations, labelled diagrams with explanatory notes; lists of points with linking sentences; labelled tables and graphs; and annotated flow diagrams with introductory notes.

## Appendix 1 – Grade descriptions Year 12

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. Interprets information to describe trends or relationships in detail. Makes accurate predictions. Selects and accurately evaluates scientific information from a variety of sources to present logical, well-developed arguments which are supported by relevant, detailed evidence. Accurately interprets data and diagrams. Describes complex relationships between data and concepts using appropriate terminology and conventions. Accurately performs calculations expressing answers using correct units.

### Science inquiry skills

Formulates a testable hypothesis that clearly states the relationship between dependent and independent variables. Designs investigations to identify and control appropriate variables; describes the experimental method in detail and accurately collects data. Organises data logically and accurately processes data. Presents data in a range of forms, including graphs, tables and charts to reveal patterns and relationships. Comprehensively explains trends using numerical data, where appropriate, and uses evidence to draw conclusions that relate to the hypothesis. Evaluates the experimental method and provides specific relevant suggestions to improve the validity and reliability of the data collected. Communicates detailed information and concepts logically and coherently, using appropriate scientific language and conventions.

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 lacking detail. Interprets information to describe trends or relationships and makes predictions. Selects and evaluates scientific information from a variety of sources to present logical arguments which are supported by relevant evidence. Interprets most data and diagrams correctly. Describes relationships between data and concepts using appropriate terminology and conventions. Solves calculations with only minor inaccuracies.

### Science inquiry skills

Formulates a testable hypothesis that states the relationship between dependent and independent variables. Designs investigations to identify and control appropriate variables, describes the experimental method and accurately collects data. Organises data logically and usually processes data accurately. Presents data in a range of forms, including graphs, tables and charts to reveal patterns and relationships. Explains trends using some numerical data, where appropriate, and uses evidence to draw conclusions that relate to the hypothesis. Evaluates the experimental method and provides relevant suggestions to improve the validity and reliability of the data collected. Communicates information and concepts logically, using appropriate scientific language and conventions.

C

**Understanding and applying concepts**

Applies models and scientific principles to describe simple systems and processes.  
Provides examples in some responses. Draws diagrams that contain minor inaccuracies or omissions.  
Provides responses to unfamiliar contexts which are generic and lack specific application of scientific knowledge.

Interprets information to describe simple trends or relationships using appropriate terminology.  
Selects some scientific information to provide generalised arguments or statements supported by some evidence.

Responses lack detail and may include irrelevant information.

Interprets some data and diagrams correctly.

Describes simple relationships between data and concepts using appropriate terminology and conventions.

Solves simple calculations with only minor inaccuracies.

**Science inquiry skills**

Formulates a testable hypothesis that links the dependent and independent variables.

Designs investigations to identify and control some variables; briefly outlines the experimental method and collects data.

Organises and processes data with some errors or omissions. Presents data using basic tables and appropriate graphs.

Describes trends in the 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**

Incorrectly applies scientific concepts to describe systems and processes.

Inconsistently applies models and includes some irrelevant or incorrect information.

Inconsistently applies scientific knowledge to unfamiliar contexts.

Attempts to interpret information and identify relationships using inappropriate terminology.

Presents statements of ideas with limited development of an argument. Makes little use of evidence.

Includes several inaccuracies in the interpretation of data and diagrams.

Incorrectly describes the relationships between data and concepts, using inappropriate terminology.

Performs calculations with errors and omissions.

**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 the data incorrectly or overlooks trends.

Offers simple conclusions that are not supported by the data or are not related to the hypothesis.

Provides trivial or irrelevant suggestions for improving the investigation.

Communicates information using everyday language with frequent 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.

## Appendix 2 – Glossary

This glossary is provided to enable a common understanding of the key terms in this syllabus.

<b>Accuracy</b>	The extent to which a measurement result represents the quantity it purports to measure; an accurate measurement result includes an estimate of the true value and an estimate of the uncertainty.
<b>Animal ethics</b>	Consideration of respectful, fair and just treatment of animals. The use of animals in science involves consideration of replacement (substitution of insentient materials for conscious living animals), reduction (using only the minimum number of animals to satisfy research statistical requirements) and refinement (decrease in the incidence or severity of 'inhumane' procedures applied to those animals that still have to be used).
<b>Data</b>	The plural of datum; the measurement of an attribute, for example, the volume of gas or the type of rubber. This does not necessarily mean a single measurement: it may be the result of averaging several repeated measurements. Data may be quantitative or qualitative and be from primary or secondary sources.
<b>Evidence</b>	In science, evidence is data that is considered reliable and valid and which can be used to support a particular idea, conclusion or decision. Evidence gives weight or value to data by considering its credibility, acceptance, bias, status, appropriateness and reasonableness.
<b>Field work</b>	Observational research undertaken in the normal environment of the subject of the study.
<b>Genre</b>	The categories into which texts are grouped; genre distinguishes texts on the basis of their subject matter, form and structure (for example, scientific reports, field guides, explanations, procedures, biographies, media articles, persuasive texts, narratives).
<b>Hypothesis</b>	A scientific statement based on the available information that can be tested by experimentation. When appropriate, the statement expresses an expected relationship between the independent and dependent variables for observed phenomena.
<b>Investigation</b>	A scientific process of answering a question, exploring an idea or solving a problem, that requires activities, such as planning a course of action, collecting data, interpreting data, reaching a conclusion and communicating these activities. Investigations can include observation, research, field work, laboratory experimentation and manipulation of simulations.
<b>Law</b>	A statement describing invariable relationships between phenomena in specified conditions, frequently expressed mathematically.
<b>Measurement error</b>	The difference between the measurement result and a currently accepted or standard value of a quantity.
<b>Media texts</b>	Spoken, print, graphic or electronic communications with a public audience. Media texts can be found in newspapers, magazines and on television, film, radio, computer software and the internet.
<b>Mode</b>	The various processes of communication – listening, speaking, reading/viewing and writing/creating.

<b>Model</b>	A representation that describes, simplifies, clarifies or provides an explanation of the workings, structure or relationships within an object, system or idea.
<b>Primary data</b>	Data collected directly by a person or group.
<b>Primary source</b>	Report of data created by the person or persons directly involved in observations of one or more events, experiments, investigations or projects.
<b>Reliable data</b>	Data that has been judged to have a high level of reliability; reliability is the degree to which an assessment instrument or protocol consistently and repeatedly measures an attribute, achieving similar results for the same population.
<b>Reliability</b>	The degree to which an assessment instrument or protocol consistently and repeatedly measures an attribute, achieving similar results for the same population.
<b>Representation</b>	A verbal, visual, physical or mathematical demonstration of understanding of a science concept or concepts. A concept can be represented in a range of ways and using multiple modes.
<b>Research</b>	To locate, gather, record, attribute and analyse information in order to develop understanding.
<b>Research ethics</b>	Norms of conduct that determine ethical research behaviour; research ethics are governed by principles, such as honesty, objectivity, integrity, openness and respect for intellectual property and include consideration of animal ethics.
<b>Risk assessment (in the school/agricultural college context)</b>	Evaluations performed to identify, assess and control hazards in a systematic way that is consistent, relevant and applicable to all school activities. Requirements for risk assessments related to particular activities will be determined by jurisdictions, schools or teachers as appropriate.
<b>Secondary data</b>	Data collected by a person or group other than the person or group using the data.
<b>Secondary source</b>	Information that has been compiled from records of primary sources by a person or persons not directly involved in the primary event.
<b>Simulation</b>	A representation of a process, event or system which imitates a real or idealised situation.
<b>System</b>	A group of interacting objects, materials or processes that form an integrated whole. Systems can be open or closed.
<b>Theory</b>	A set of concepts, claims and/or laws that can be used to explain and predict a wide range of related observed or observable phenomena. Theories are typically founded on clearly identified assumptions, are testable, produce reproducible results and have explanatory power.
<b>Uncertainty</b>	Range of values for a measurement result, taking account of the likely values that could be attributed to the measurement result, given the measurement equipment, procedure and environment.
<b>Validity</b>	The extent to which tests measure what was intended; the extent to which data, inferences and actions produced from tests and other processes are accurate.