Stage 2 Science Subjects Implementation

Workshop Booklet

2017

Government of South Australia

SACE Board of SA

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CONTENTS

Science Inquiry Skills

Science Inquiry Skills	Possible Contexts
Scientific methods enable systematic investigation to obtain measureable evidence. • Deconstruct the parts of a problem to determine the most appropriate method for investigation. • Design investigations, including: ◆ a hypothesis or inquiry question ◆ types of variables – dependent – independent – factors held constant (how and why they are controlled) – factors that may not be able to be controlled (and why not) ◆ materials required ◆ the procedure to be followed ◆ the type and amount of data to be collected ◆ identification of ethical and safety considerations.	Develop inquiry skills by, for example: • designing investigations that require investigable questions and imaginative solutions (with or without implementation) • critiquing proposed investigations • using the conclusion of one investigation to propose subsequent experiments • changing an independent variable in a given procedure and adapting the method • researching, developing, and trialling a method • improving an existing procedure • identifying options for measuring the dependent variable • researching hazards related to the use and disposal of chemicals and/or biological materials • developing safety audits • identifying relevant ethical and/or legal considerations in different contexts.
Obtaining meaningful data depends on conducting investigations using appropriate procedures and safe, ethical working practices. • Conduct investigations, including: ◆ selection and safe use of appropriate materials, apparatus, and equipment ◆ collection of appropriate primary and/or secondary data (numerical, visual, descriptive) ◆ individual and collaborative work.	Develop inquiry skills by, for example: • identifying equipment, materials, or instruments fit for purpose • practising techniques and safe use of apparatus • comparing resolution of different measuring tools • distinguishing between, and using, primary and secondary data.
Results of investigations are represented in a well-organised way to allow them to be interpreted. • Represent results of investigations in appropriate ways, including: ◆ use of appropriate SI units, symbols ◆ construction of appropriately labelled tables ◆ drawing of graphs: linear, non-linear, lines of best fit ◆ use of significant figures.	Develop inquiry skills by, for example: • practising constructing tables to tabulate data, including column and row labels with units • identifying the appropriate representations to graph different data sets • selecting appropriate axes and scales to graph data • clarifying understanding of significant figures using, for example: www.astro.yale.edu/astro120/SigFig.pdf www.hccfl.edu/media/43516/sigfigs.pdf www.physics.uoguelph.ca/tutorials/sig_fig/SIG_dig.htm • comparing data from different sources to describe as quantitative or qualitative.

Science Inquiry Skills	Possible Contexts
Scientific information can be presented using different types of symbols and representations. • Select, use, and interpret appropriate representations, including: ◆ mathematical relationships, such as ratios ◆ diagrams ◆ equations to explain concepts, solve problems, and make predictions.	Develop inquiry skills by, for example: • writing chemical equations • drawing and labelling diagrams • recording images • constructing flow diagrams.
Analysis of the results of investigations allows them to be interpreted in a meaningful way. • Analyse data, including: ◆ identification and discussion of trends, patterns, and relationships ◆ interpolation/extrapolation where appropriate ◆ selection and use of evidence and scientific understanding to make and justify conclusions.	Develop inquiry skills by, for example: • analysing data sets to identify trends and patterns • determining relationships between independent and dependent variables • using graphs from different sources, e.g. CSIRO or the Australian Bureau of Statistics (ABS), to predict values other than plotted points • calculating mean values and rates of reaction, where appropriate.
Critical evaluation of procedures and outcomes can determine the meaningfulness of conclusions. • Identify sources of uncertainty, including: ◆ random and systematic errors ◆ control of variables • Evaluate the procedures and results, including: ◆ sample size ◆ detecting systematic error ◆ accuracy ◆ reliability ◆ precision ◆ validity. • Discuss the impact that sources of uncertainty have on experimental results. • Recognise the limitations of conclusions.	Develop inquiry skills by, for example: • evaluating procedures and data sets provided by the teacher to determine and hence comment on the limitations of possible conclusions • discussing how the repeating of an investigation with different materials/equipment may detect a systematic error • using an example of an investigation report to develop report-writing skills. Useful website: www.biologyjunction.com/sample%20ap%20lab%20reports.htm
Effective scientific communication is clear and concise. • Communicate to specific audiences and for specific purposes using: ◆ appropriate language ◆ terminology ◆ conventions.	Develop inquiry skills by, for example: • reviewing scientific articles or presentations to recognise conventions • developing skills in referencing and/or footnoting • distinguishing between reference lists and bibliographies • practicing scientific communication in written, oral, and multimedia formats (e.g. presenting a podcast or writing a blog).

Science as a Human Endeavour

The key concepts of science as a human endeavour underpin the contexts, approaches, and activities in this subject, and must be integrated into all teaching and learning programs.

The key concepts of science as a human endeavour in the study of science are:

Communication and Collaboration

- Science is a global enterprise that relies on clear communication, international conventions, and review and verification of results.
- International collaboration is often required in scientific investigation.

Development

- Development of complex scientific models and/or theories often requires a wide range of evidence from many sources and across disciplines.
- New technologies improve the efficiency of scientific procedures and data collection and analysis. This can reveal new evidence that may modify or replace models, theories, and processes.

Influence

- Advances in scientific understanding in one field can influence and be influenced by other areas of science, technology, engineering, and mathematics.
- The acceptance and use of scientific knowledge can be influenced by social, economic, cultural, and ethical considerations.

Application and Limitation

- Scientific knowledge, understanding, and inquiry can enable scientists to develop solutions, make discoveries, design action for sustainability, evaluate economic, social, cultural, and environmental impacts, offer valid explanations, and make reliable predictions.
- The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation.
- Science informs public debate and is in turn influenced by public debate; at times, there may be complex, unanticipated variables or insufficient data that may limit possible conclusions.

Biology

SACE Stage 1	SACE Stage 2
Topic 1: Cells and Microorganisms - cell theory - prokaryotic and eukaryotic cell types - cell division - energy (photosynthesis and respiration) - transport of materials - enzymes and metabolic pathways - microorganisms - growth and survival - importance of microbes - food spoilage **Topic 2: Infectious Disease** - distinguish between disease types - factors that affect disease spread - control of disease - pathogens - immune system - components, functions, and immunity **Topic 3: Multicellular Organisms** - hierarchal structure - organ systems - lifestyle choices affect human health - exchange –circulatory and respiratory systems in humans, leaf structure, xylem and phloem in plants - absorption of nutrients- digestive system in humans, root system in plants - removal of wastes- excretory system in humans **Topic 4: Biodiversity and Ecosystem Dynamics** - species, community and populations - biodiversity - classification - adaptations - diversity of ecosystems - cycles: water, nitrogen etc. - relationships and interactions, keystone species - succession - human impact on ecosystems	**DNA and Proteins** - structure and properties of DNA, replication - genes: introns and exons - protein synthesis, protein folding, enzymes - gene expression - mutation - mitosis and meiosis - DNA sequencing and PCR - biotechnology using DNA **Cells as the Basis of Life** - cell theory - cell types - organelles - cell requirements: energy and exchange of materials - movement of materials in and out of cells - biochemical processes - cell division **Homeostasis** - tolerance limits - body temperature - water/osmoregulation - blood glucose - carbon dioxide - nervous system - endocrine system - stimulus response/negative feedback **Evolution** - role of RNA and ribozymes - fossil evidence for evolution - endosymbiosis - comparative genomics - species definition - reproductive isolation - mutations - variation/genetic diversity - gene pool - natural selection - speciation (allopatric, convergent, adaptive radiation) - human activities, species extinction and preservation
Science Inquiry Skills **Science as a Human Endeavour**	

Chemistry

SACE Stage 1	SACE Stage 2
Topic 1: Materials and their Atoms 1.1 Properties and uses of materials 1.2 Atomic structure 1.3 Quantities of atoms 1.4 The Periodic Table **Topic 2: Combining Atoms** 2.1 Types of materials 2.2 Bonding (primary) between atoms 2.3 Quantities of molecules and ions **Topic 3: Molecules** 3.1 Molecular polarity 3.2 Interactions between molecules 3.3 Hydrocarbons 3.4 Polymers **Topic 4: Mixtures and Solutions** 4.1 Miscibility and solutions 4.2 Solutions of ionic substances 4.3 Quantities in reactions 4.4 Energy in reactions **Topic 5: Acids and Bases** 5.1 Acid – base concepts 5.2 Reactions of acids and bases 5.3 The pH scale **Topic 6: Redox reactions** 6.1 Concepts of Oxidation and Reduction 6.2 Metal reactivity 6.3 Electrochemistry	**Topic 1: Monitoring the Environment** 1.1 Global Warming and Climate Change 1.2 Photochemical Smog 1.3 Volumetric Analysis 1.4 Chromatography 1.5 Atomic Spectroscopy **Topic 2: Managing Chemical Processes** 2.1 Rates of Reactions 2.2 Equilibrium and yield 2.3 Optimising production **Topic 3: Organic and Biological Chemistry** 3.1 Introduction 3.2 Alcohols 3.2 Aldehydes and Ketones 3.4 Carbohydrates 3.5 Carboxylic Acids 3.6 Amines 3.7 Esters 3.8 Amides 3.9 Triglycerides 3.10 Proteins **Topic 4: Managing Resources** 4.1 Energy 4.2 Water 4.3 Soil 4.4 Materials
Science Inquiry Skills **Science as a Human Endeavour**	

Earth and Environmental Science

SACE Stage 1	SACE Stage 2
Topic 1: Turbulent Earth - Earth hazards - processes within the geosphere - impact of extra-terrestrial bodies on Earth systems **Topic 2: Composition of the Geosphere** - minerals - rocks - interactions between spheres - time scale **Topic 3: Processes in the Geosphere** - principle of uniformitarianism - layered structure of the Earth - transfers and transformations of energy **Topic 4: The Earth's Atmosphere** - derivation of the Earth's atmosphere - changes in composition - layers in the atmosphere - solar energy through the atmosphere - greenhouse gases - transfer of thermal energy **Topic 5: Importance of the Hydrosphere** - origin of water on Earth - three phases of water - global oceans **Topic 6: Biosphere** - fossil evidence - how life emerged - interactions between spheres - fossil evidence - ecosystems - cycles	**Topic 1: Earth Systems** - four Earth systems - change and interaction between systems **Topic 2: Earth's Resources** - uses of geological resources - non-renewable resources - discovery techniques - extraction of resources **Topic 3: Earth's Sustainable Future** - renewable resources - water - energy **Topic 4: Climate Change** - natural processes in the atmosphere - astronomical impact - natural processes within the Earth - oceans - anthropogenic activities - effects on Earth's systems - models of change

Science Inquiry Skills
Science as a Human Endeavour

Physics

SACE Stage 1	SACE Stage 2
Topic 1: Linear Motion and Forces 1.1 Motion under constant acceleration 1.2 Forces **Topic 2 Electric Circuits** 2.1 Potential Difference and Electric Current 2.2 Resistance 2.3 Circuit Analysis 2.4 Electrical Power **Topic 3 Heat** 3.1 Heat and Temperature 3.2 Specific Heat Capacity 3.3 Change State **Topic 4 Energy and Momentum** 4.1 Energy 4.2 Momentum **Topic 5 Waves** 5.1 Wave model 5.2 Mechanical Waves 5.3 Light **Topic 6 Nuclear models and radioactivity** 6.1 The Nucleus 6.2 Radioactive Decay 6.3 Radioactive Half-life 6.4 Induced Nuclear Reactions	**Topic 1 Motion and Relativity** 1.1 Projectile motion 1.2 Forces and Momentum 1.3 Circular Motion and Gravitation 1.4 Einstein's Relativity **Topic 2 Electricity and Magnetism** 2.1 Electric fields 2.2 Motion of Charged Particles in Electric Fields 2.3 Magnetic Fields 2.4 Motion of Charged Particles in Magnetic Fields 2.5 Electromagnetic Induction **Topic 3 Light and Atoms** 3.1 Wave Behaviour of Light 3.2 Wave-Particle Duality 3.3 Structure of the Atom 3.4 Standard Model

Science Inquiry Skills
Science as a Human Endeavour

Summary of Assessment: Stage 2 science subjects from 2018			
Subject	*School Assessment: Assessment Type 1*	*School Assessment: Assessment Type 2*	*External Assessment: Assessment Type 3*
Stage 2 Biology	**Investigations Folio (30%)** • At least *two* practical investigations • *One* science as a human endeavour investigation	**Skills and Applications Tasks (40%)** • At least *three* SATs	**Examination (30%) – 2 hours**
Stage 2 Chemistry	**Investigations Folio (30%)** • At least *two* practical investigations • *One* science as a human endeavour investigation	**Skills and Applications Tasks (40%)** • At least *three* SATs	**Examination (30%) – 2 hours** A data sheet will be provided
Stage 2 Earth and Environmental Science	**Investigations Folio (30%)** • At least *two* practical investigations • *One* science as a human endeavour investigation	**Skills and Applications Tasks (40%)** • At least *three* SATs	**One Earth Systems Study** Maximum of 2000 words
Stage 2 Physics	**Investigations Folio (30%)** • At least *two* practical investigations • *One* science as a human endeavour investigation	**Skills and Applications Tasks (40%)** • At least *three* SATs	**Examination (30%) – 2 hours** A data sheet will be provided

Notes:

- Number of Assessments: eight assessments including the external assessment component.
- AT1: Investigations Folio – practical report - maximum of 1500 words (Introduction, analysis, evaluation, conclusion) if written, or the equivalent in multimodal form
- AT1: Investigations Folio – Science as a human endeavour task - maximum of 1500 words if written, or the equivalent in multimodal form
- AT1: Investigations Folio - at least one practical investigation gives each student the opportunity to design the method
- AT2: Skills and Applications Tasks – at least two under direct supervision
- AT2: Skills and Applications Tasks – each task under direct supervision to a maximum of 90 minutes.
- One investigation or skills and application task should involve collaborative work.

Stage 2 Assessment Design Criteria and Specific Features

The assessment design criteria are based on the learning requirements and are used by teachers to:

- clarify for the student what he or she needs to learn
- design opportunities for the student to provide evidence of his or her learning at the highest level of achievement.

The assessment design criteria consist of specific features that:

- students need to demonstrate in their evidence of learning
- teachers look for as evidence that students have met the learning requirements.

The set of assessments, as a whole give students opportunities to demonstrate each of the specific features by the completion of study of the subject.

Biology

Investigation, Analysis, and Evaluation		Knowledge and Application	
IAE1	Design of a biological investigation	KA1	Demonstration of knowledge and understanding of biological concepts
IAE2	Obtaining, recording, and representation of data, using appropriate conventions and formats	KA2	Development and application of biological concepts in new and familiar contexts
IAE3	Analysis and interpretation of data and other evidence to formulate and justify conclusions	KA3	Exploration and understanding of the interaction between science and society
IAE4	Evaluation of procedures and their effect on data.	KA4	Communication of knowledge and understanding of biological concepts and information, using appropriate terms, conventions, and representations.

Chemistry

Investigation, Analysis, and Evaluation		Knowledge and Application	
IAE1	Design of a chemistry investigation	KA1	Demonstration of knowledge and understanding of chemical concepts
IAE2	Obtaining, recording, and representation of data, using appropriate conventions and formats	KA2	Development and application of chemical concepts in new and familiar contexts
IAE3	Analysis and interpretation of data and other evidence to formulate and justify conclusions	KA3	Exploration and understanding of the interaction between science and society
IAE4	Evaluation of procedures and their effect on data.	KA4	Communication of knowledge and understanding of chemical concepts and information, using appropriate terms, conventions and representations.

Earth and Environmental Science

Investigation, Analysis, and Evaluation		Knowledge and Application	
IAE1	Design of an earth and environmental science investigation	KA1	Demonstration of knowledge and understanding of earth and environmental science concepts.
IAE2	Obtaining, recording, and representation of data, using appropriate conventions and formats	KA2	Development and application of earth and environmental science concepts in new and familiar contexts
IAE3	Analysis and interpretation of data and other evidence to formulate and justify conclusions	KA3	Exploration and understanding of the interaction between science and society
IAE4	Evaluation of procedures and their effect on data.	KA4	Communication of knowledge and understanding of earth and environmental science concepts and information, using appropriate terms, conventions, and representations.

Physics

Investigation, Analysis, and Evaluation		Knowledge and Application	
IAE1	Design of a physics investigation.	KA1	Demonstration of knowledge and understanding of physics concepts.
IAE2	Obtaining, recording, and representation of data, using appropriate conventions and formats.	KA2	Development and application of physics concepts in new and familiar contexts.
IAE3	Analysis and interpretation of data and other evidence to formulate and justify conclusions.	KA3	Exploration and understanding of the interaction between science and society
IAE4	Evaluation of procedures and their effect on data.	KA4	Communication of knowledge and understanding of physics concepts and information, using appropriate terms, conventions, and representations.

Performance Standards for Stage 2 Biology

	Investigation, Analysis and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed biological investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of biological concepts. Develops and applies biological concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of biology coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear biological investigation. Obtains, records, and represents data using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of biological concepts. Develops and applies biological concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of biology mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear biological investigation. Obtains, records, and represents data using generally appropriate conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of biological concepts. Develops and applies biological concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of biology generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of a biological investigation. Obtains, records, and represents data using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of biological concepts. Develops and applies some biological concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic biological information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a biological investigation. Attempts to record and represent some data with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of biological concepts. Attempts to develop and apply biological concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about biology.

Performance Standards for Stage 2 Chemistry

	Investigation, Analysis and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed chemistry investigation. Obtains records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and discusses their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of chemical concepts. Develops and applies chemical concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of chemistry coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear chemistry investigation. Obtains, records, and represents data using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of chemical concepts. Develops and applies chemical concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of chemistry mostly coherently, with effective use of appropriate terms, conventions, and representations.
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E	Identifies a simple procedure for a chemistry investigation. Attempts to record and represent some data with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of chemical concepts. Attempts to develop and apply chemical concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about chemistry.

Performance Standards for Stage 2 Earth and Environmental Science

	Investigation, Analysis and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed earth and environmental science investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science coherently with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear earth and environmental science investigation. Obtains, records, and represents data using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science mostly coherently with effective use of appropriate terms, conventions, and representations.
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D	Prepares the outline of a earth and environmental science investigation. Obtains, records, and represents data using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of earth and environmental science concepts. Develops and applies some earth and environmental science concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society Communicates basic earth and environmental science information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a earth and environmental science investigation. Attempts to record and represent some data with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of earth and environmental science concepts. Attempts to develop and apply earth and environmental science concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society Attempts to communicate information about earth and environmental science.

Performance Standards for Stage 2 Physics

	Investigation, Analysis and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed, physics investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of physics concepts. Develops and applies physics concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of physics coherently with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear physics investigation. Obtains, records, and represents data using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts. Develops and applies physics concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of physics mostly coherently with effective use of appropriate terms, conventions, and representations.
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Government of South Australia

SACE Board of SA

SCHOOL-DEVELOPED LEARNING AND ASSESSMENT PLAN FORM

Stage 2 Biology

School _____ Teacher(s) _____

Other schools using this plan _____

SACE School Code			Year	Enrolment Code					Program Variant Code (A–W)
				Stage	Subject Code			No. of Credits (10 or 20)	
				2	B	G	Y	20	

Endorsed by principal or delegate (signature) _____ Date _____

Office use only

Approved ☐ Not approved ☐ ☐☐☐☐☐☐☐☐

Accession Number

Signature of SACE Board Officer _____

SACE Board Officer Number _____ Date _____

Addendum

Please **only** use this section for any changes made after the learning and assessment plan has been approved.

Changes made to the learning and assessment plan

Describe any changes made to the learning and assessment plan to support students to be successful in meeting the requirements of the subject. In your description, please explain:

- what changes have been made to the plan
- the rationale for making the changes
- whether these changes have been made for all students, or individuals within the student group.

Endorsement of changes

The changes made to the learning and assessment plan support student achievement of the performance standards and retain alignment with the subject outline.

Signature of principal or delegate _____ Date _____

Stage 2 Biology

Assessment Overview

Complete the table below to show details of the planned tasks. Use numbers to show where students will have the opportunity to provide evidence for each of the specific features for all assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio				
Weighting 30%				
Assessment Type 2: Skills and Applications Tasks				
Weighting 40%				
Assessment Type 3: Examination	2-hour examination	All specific features of the assessment design criteria for this subject may be assessed in the external examination. Questions of different types cover all Stage 2 topics and science inquiry skills. Some questions may require students to integrate their knowledge from more than one topic and show an understanding of science as a human endeavour.		
Weighting 30%				

Eight assessments including the external examination or investigation. *Please refer to the Stage 2 Biology subject outline.*

Stage 2 Biology Teaching and Learning Plan 2018

This teaching and learning program articulates with learning and assessment plan 1

Teacher:		Learning Area:	Science	Subject:	Biology	Year level:	12	SACE:	Stage 2
Semester:	1								

Timeline Week	Student Understanding	Strategies, Contexts, and Activities	Summative Assessment Tasks
	TOPIC: DNA and PROTEINS		
Term 1 Week 1	**DNA STRUCTURE AND FUNCTION** • Review the differences between prokaryotic and eukaryotic cells. • Describe the structure and functions of DNA • Explain the process of DNA replication	• **Worksheet:** Label diagrams of prokaryotic and eukaryotic cells. • **Formative Research Assignment:** Explore the work of Watson, Crick, Franklin, and Wilkins in the discovery of the structure of DNA. (**SHE** – Communication and Collaboration, Development) • **Class Activity**: Construct and use models of DNA replication. • **Experiment (SIS):** Extraction of DNA (e.g. from peas). Deconstruct: Different sources of DNA for different purposes- best method to extract?	
2	**DNA STRUCTURE AND FUNCTION (Cont.)** • Explain that base-pairing rules and DNA replication are universal • Gene structure: Compare introns and exons • Describe the function of a gene • The process of transcription and translation- and the roles of the components involved	• **Class Activity:** Students demonstrate a conceptual understanding of the process of transcription and translation by becoming codons, anticodons and amino acids in a role-play of protein synthesis. • **Activity:** List some of the end products of genes including functional proteins, tRNA, rRNA and microRNA.	
3	**PROTEIN STRUCTURE AND FUNCTIONS** • Describe the factors that determine the primary, secondary, tertiary and quaternary structure of proteins • Explain how the structure of a protein is critical to its function. • Define the function of various structural and functional proteins (e.g. hormones, receptor proteins)	• **Group Activity:** Draw labelled diagrams of the different levels of protein structure. • **Class Discussion:** Discuss examples of structural and functional proteins (e.g. haemoglobin, antibodies). • **Experiment (SIS):** Testing for Nucleic Acids and Proteins.	

Timeline Week	Student Understanding	Strategies, Contexts, and Activities	Summative Assessment Tasks
4	**ENZYME SPECIFICITY** • Describe the enzyme-substrate complex • Explain how the induced-fit lowers the activation energy needed for reactions to proceed. • Describe how factors such as temperature, and pH affect enzyme function.	• **Research Assignment:** Investigate the design and manufacture of proteins for scientific/medicinal use, such as biochips and targeted chemotherapy. (**SHE –** Influence**,** Application and Limitation)	**Summative Practical Investigation and Deconstruct a Problem Task:** Conditions affecting enzyme activity. (Week 5)
5	**PHENOTYPIC EXPRESSION** • Describe the factors that control phenotypic expression • Describe how differential gene expression controls cell differentiation • Explain the effect of DNA methylation **EPIGENETIC CHANGES** • Explain how epigenetic modifications can lead to cancer	• **Class Discussion:** Discuss impact of DNA methylation. • **Group Activity:** Explore the work of Professor Stephen Baylin. (**SHE** - Development) • **Research:** Consider some example of diseases caused by epigenetics such as Fragile X syndrome and Rett syndrome. (**SHE –** Application and Limitation)	
6	**MUTATIONS** • Define mutations • Describe the environmental factors that cause mutations • Compare the impact of germ-line cell mutations and somatic cell mutations.	• **Worksheet:** Label a diagram of the cell cycle (including checkpoints). • **Worksheet:** Describe the effect of different mutations on the genetic code and overall protein. • **Oral Presentation:** Describe how a mutation can cause a genetic disease.	
7	**BIOTECHNOLOGY** • Explain how tools such as restriction enzymes, radioactive probes, electrophoresis and plasmids are utilised by geneticists, • Describe the processes of DNA sequencing, PCR and DNA profiling • Describe how new technologies such as CRISPR can be used to edit/transfer genes • Describe the different ways that genes can be transferred between species. • Benefits and limitations	• **Class Activity:** Debate the social and ethical advantages and consequences of the manipulation of DNA and gene therapy. (**SHE –** Application and Limitation**)** • **Group Activity:** Research and devise a table to highlight several transgenic organisms and their uses, for example in food production and the production of human hormones. • **Worksheet:** Draw a timeline showing the historical perspective of selective breeding and more recently transgenic organisms and cloning. (**SHE –** Development, Influence, Application and Limitation)	
8		Revision of topic concepts	**Summative Test:** DNA and Proteins

Timeline Week	Student Understanding	Strategies, Contexts, and Activities	Summative Assessment Tasks
	TOPIC 2: CELLS AS THE BASIS OF LIFE		
9	**CELL STRUCTURE AND FUNCTION** • Define the cell theory • Describe the structure and function of the cell membrane	• **Class Activity:** Illustrate the structure of the cell membrane. • **Practical:** Observe cells using microscope.	
10	• Compare prokaryotic and eukaryotic cells (review) • Describe the structure and function of organelles in eukaryotic cells • Compare the structure of plant and animal cells	• **Class Activity:** Use animations or video clips to highlight the differences between prokaryotic and eukaryotic cells.	
11	**ENERGY FLOW** • Compare energy flow of autotrophs with heterotrophs. • Write equations for photosynthesis, aerobic respiration, lactic acid fermentation and alcohol fermentation • Explain how the ATP/ADP conversion provides energy for use in cells.	• **Group SIS:** Investigate factors affecting anerobic respiration using yeast in solution or in a 'bread dough' mix. Deconstruct a problem. Do different yeasts really result in differernt results for each food application?	
Term 2 Week 1	**MOVEMENT OF SUBSTANCES** • Explain the different processes of movement through the cell membrane (e.g. osmosis, diffusion). • Discuss the factors that affect the movement of substances	• **Practical (SIS):** Demonstrate the affect that the size of agar cubes has on the rate of diffusion	
2	**BIOCHEMICAL PROCESSES** • Describe how the structure of mitochondria and chloroplasts is essential for cell metabolism. • Explain the reasons for energy pathways and how these pathways can be achieved **CHEMICALS AND CELLS** • Discuss possible benefits and/or harmful effects of chemicals that human beings use.	• **Worksheet:** Illustrate different energy pathways and discuss the impact of faulty enzymes • **Group Assignment:** Discuss the effects of chemicals such as cyanide, antibiotics, herbicides, and insecticides on cell metabolism. (**SHE –** Influence, Application and Limitation)	
3	**CELL DIVISION - ASEXUAL** • Review DNA replication • Describe the process of mitosis • Compare mitosis and binary fission	• **Class Activity:** View animations and use models to show the processes of binary fission and mitosis. • **Practical (SIS):** Examine the stages of mitosis in onion root tip cells.	
4	**CELL DIVISION - SEXUAL** • Describe the process of meiosis. • Explain the importance of crossing over and independent assortment in meiosis. • Compare the products of meiotic and mitotic cell division.	• **Class Activity:** Use models to represent the arrangement and movement of chromosomes during meiosis. • **Class Discussion:** Discuss the genetic manipulation of somatic and germline cells. (**SHE** – Influence, Apllication and Limitation)	

Timeline Week	Student Understanding	Strategies, Contexts, and Activities	Summative Assessment Tasks
5	**CELL CYCLE AND CELL CULTURING** • Describe the gene products and checkpoints that regulate the cell cycle • Describe the impact of carcinogens on the cell cycle • Describe techniques of cell culturing and discuss contemporary uses.	• **Social Analysis:** Investigate the effect of carcinogens (e.g. tobacco smoke, some dioxins, and asbestos) on human health and what can be done to reduce their use. (**SHE** – Influence, Application and Limitation) • **Ethical Debate:** Discuss both sides of the argument for the use of HeLa Cells (**SHE –** Influence, Application and Limitation)	
6		Revision of topic concepts	**Summative Test:** Cells as the Basis of Life
	TOPIC: HOMEOSTASIS		
7	**MAINTAINING INTERNAL ENVIRONMENT** • Define homeostasis • Give examples of tolerance limits and discuss impacts outside these limits	• **Group SIS (Over two weeks):** Investigate the effect of salinity, pH, temperature or other factors on seedlings. Deconstruct a problem: Seeds and Farming. • **Video:** Science Nation – Extreme Microbes	
8	**DETECTING AND RESPONDING** • Describe the role Nervous and Endocrine systems • Describe the different sensory receptors	• **Mini-Experiments (SIS):** Testing our Receptors	
9	**DETECTING AND RESPONDING (Cont.)** • Describe the structure and function of the nerve pathway • Describe the role and pathway of reflex responses • Using examples, describe negative feedback	• **Class Activity:** Research the biological basis of Alzheimer's or Parkinson's disease and how this relates to treatment (**SHE –** Influence, Application and Limitation) • **Mini Experiments (SIS):** Testing our reflexes	
10	**ENDOCRINE SYSTEM** • Describe the stimulus-response model • Describe the role and action of hormones (e.g. insulin and glucagon, thyroxine, ADH, TSH, adrenaline) • Diabetes	• **Worksheet:** Use a flow diagram to represent the components of the stimulus-response model • **Class Discussion:** Consider the negative consequences of using hormones in medicinal situations.	**Summative Practical Investigation:** Investigate the effect of plant hormones on plant growth.

Timeline Week	Student Understanding	Strategies, Contexts, and Activities	Summative Assessment Tasks
Term 3 Week 1	**NERVOUS AND ENDOCRINE SYSTEM** • Compare the nervous and endocrine systems • Discuss how the two systems work together and independently o control body temperature o enable osmoregulation o maintain blood sugar levels o monitor carbon dioxide to maintain constant pH	• **Practical (SIS):** Kidney Dissection - consider the ethical and safety issues of using animal organs • **Poster:** Illustrate the effect of ADH on the nephron	
2		Revision of topic concepts	**Summative Test:** Homeostasis
	TOPIC: EVOLUTION		
3	**LIFE ON EARTH** • Discuss evidence of when life began on Earth (e.g. fossils) • Describe spontaneous forming membranes and ribozymes • Describe the Theory of Endosymbiosis	• **Class Activity:** Compare the characteristics of all known life forms • **Review:** Structure and function of mitochondria and chloroplasts • **Research:** The work of Nobel Prize winners Altman, Cech and Jack Szostak. (**SHE –** Communication and Collaboration, Development)	**Summative Science as a Human Endeavour Investigation:** Select a topic related to Human Endeavour
4	**COMPARATIVE GENOMICS** • Describe techniques of obtaining evolutionary relationships between species • Draw and/or analysis simple phylogenetic trees.	• **Class Activity:** Develop a time-line for biological change (e.g. Nuffield activity) • **Assignment:** Research one innovative technologies utilised in comparative genomics (**SHE –** Influence)	
5	**REPRODUCTIVE ISOLATION** • Define a species • Describe reproductive isolating mechanisms	• **Class Activity:** Discuss the limitations of the species definition • **Practical (SIS):** Separate pictures given into pre- and post-zygotic mechanisms.	
6	**GENETIC VARIATION** • Describe the impact of mutations on a species • Explain how meiosis also ensures variation • Explain the impact of natural selection	• **Class activity:** Students describe the impact that many different abiotic and biotic selection pressures have on organisms. Deconstruct activity: How can you show that antiseptics act as selecting agents? • **Field Trip (SIS):** Analyse food webs and selection pressures	

Timeline Week	Student Understanding	Strategies, Contexts, and Activities	Summative Assessment Tasks
		existing within local wetlands. (**SHE –** Influence, Application and Limitation) • Experiment (SIS): Natural Selection modelling- analysis of data, limitations of models.	
7	**EVOLUTIONARY CHANGE** • Describe how micro changes leads to macro-evolutionary changes • Define genetic drift and gene flow • Explain the process of speciation	• **Assignment:** Research Darwin & Wallace and their contribution to the understanding of evolution. (**SHE –** Communication and Collaboration, Development)	
8	**CONVERGENT AND DIVERGENT EVOLUTION** • Define convergent, divergent and adaptive radiation • Describe the process of succession	• **Worksheet:** Consider examples of populations with reduced genetic diversity including cheetahs and Tasmanian devils. (**SHE –** Application and Limitation)	
9	**HUMAN IMPACT** • Give examples of human activities that have caused or may threaten the extinction of species. • Ensure the students recognise that humans have an ethical obligation to prevent species extinction.	• **Class Brainstorm:** Investigate local, national or global human activities that have had (or are having) a significant effect on species • **Essay:** Research and describe the steps being taken to preserve species.. (**SHE –** Application and Limitation)	
10		Revision of topic concepts	**Summative Test:** Evolution

Stage 2 Biology (20-credits)

Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio **Weighting 30%**	**Conditions affecting Enzyme Activity**: Students carry out an Investigation analysing the effect that conditions such as temperature, pH, substrate concentration, product concentration have on enzyme activity. They record and analyse results, evaluate procedures, and justify their conclusion. Students consider enzymes in industry and deconstruct a problem relating to this. They suggest possible solutions.	2,3, 4	4	**Practical Completion Investigation:** Maximum 1500 words or multimodal equivalent (excluding materials, methods, safety, results) Investigation completed in 90 minutes. Practical report completed in 3 days.
	Effect of Hormones on Plant Growth: Students individually design and carry out an investigation that analyses the effect of hormones on plant growth. They undertake the practical investigation collaboratively; however each student submits an individual practical report.	1,2,3,4		**Practical Design Investigation:** Maximum 1500 words or multimodal equivalent (excluding materials, methods, safety, results) Design 1 lesson. Investigation completed over three weeks. Practical report completed in 3 days.
	Science as a Human Endeavour Investigation: Students investigate an aspect of biology with a focus on Science as a Human Endeavour. The scientific communication must emphasise one of the SHE understandings described in the subject outline. They access information from different sources, select relevant information, analyse their findings, and develop and justify their own conclusions from the investigation.	3	1,3,4	**Science as a Human Endeavour Investigation:** Maximum 1500 words or a maximum of 10 minutes oral presentation or multimodal equivalent. Draft submitted in 1 week. SHE Investigation to be completed in 3 weeks.
Assessment Type 2: Skills and Applications Tasks **Weighting 40%**	**DNA and Proteins Test:** Students demonstrate knowledge and understanding of the key biological concepts and learning in the DNA and Proteins theme, and apply this knowledge to solve problems in new and familiar contexts. Students analyse biological problems and pose solutions using appropriate biological terms and conventions in multiple-choice and short-answer questions.	2	1,2,4	**DNA and Protein Test:** Individually completed 90-minute supervised test
	Cells as the Basis of Life Test: Students demonstrate knowledge and understanding of the key biological concepts and learning in the topic Cells as the Basis of Life, and apply this knowledge to solve problems in new and familiar contexts. Students represent data using appropriate conventions and formats. Students analyse biological problems and pose solutions using appropriate biological terms and conventions in multiple-choice, short-answer questions and an extended response.	2	1,2,4	**Cells as the Basis of Life Test:** Individually completed 90-minute supervised test
	Homeostasis Test: Students demonstrate knowledge and understanding of the key biological concepts and learning in the Homeostasis topic, and apply this knowledge to solve problems in new and familiar contexts. Students analyse data and evidence to formulate logical conclusions. Students analyse biological problems and pose solutions using appropriate biological terms and conventions in multiple-choice, short-answer questions and an extended response. Some questions require the use of science inquiry skills.	1, 3	1,2,4	**Homeostasis Test:** Individually completed 90-minute supervised test
	Evolution Test: Students demonstrate knowledge and understanding of the key biological concepts and learning in the Evolution topic, and apply this knowledge to solve problems in a test. Students analyse biological problems and pose solutions using appropriate biological terms and conventions in multiple choice, short answer questions and an extended response. The extended response will relate to the science as a human endeavour component of the subject.	2	1,3,4	**Evolution Test:** Individually completed 90-minute supervised test
External Examination **Weighting 30%**	2-hour examination	All specific features of the assessment design criteria for this subject may be assessed in the external examination. Questions of different types cover all Stage 2 topics and the science inquiry skills. Some questions may require students to integrate their knowledge from more than one topic and show an understanding of science as a human endeavour.		

Eight assessments including the external examination. *Please refer to the draft Stage 2 Biology subject outline.*

Stage 2 Biology: Investigation Folio

Science as a Human Endeavour Task

Introduction and Purpose of task:

In this task you will have the opportunity to investigate and demonstrate a comprehensive understanding of the how human ingenuity and application of biological knowledge and understanding can be used to improve human lives and to consider the impact of this development, for example: what the limitations may be. This investigation is related to Topic 3: Homeostasis and specifically the nervous system. The focus of this task is to undertake research on the Biology highlighted in the article provided (Bionic finger can feel textures, New Scientist, 12th March 2016, pg. 12) and demonstrate an understanding of how this article and related Biology gives insight into how Humans interact with and use biological knowledge to develop new technologies and design solutions to issues and problems.

You will use and acknowledge a variety of relevant sources to find data and information to support your chosen topic.

You may choose to present your research findings as a written report providing an expert's point of view including an analysis of the development of the technology, the interaction between scientists and other fields, and/or the economic, social, environmental or political implications.

Your research, findings and outcome should have a focus on **at least one** of the key concepts of Science as a Human Endeavour listed below:

Communication and Collaboration

- Science is a global enterprise that relies on clear communication, international conventions, and review and verification of results.
- International collaboration is often required in scientific investigation.

Development

- Development of complex scientific models and/or theories often requires a wide range of evidence from many sources and across disciplines.
- New technologies improve the efficiency of scientific procedures and data collection and analysis. This can reveal new evidence that may modify or replace models, theories, and processes.

Influence

- Advances in scientific understanding in one field can influence and be influenced by other areas of science, technology, engineering, and mathematics.
- The acceptance and use of scientific knowledge can be influenced by social, economic, cultural, and ethical considerations.

Application and Limitation

- Scientific knowledge, understanding, and inquiry can enable scientists to develop solutions, make discoveries, design action for sustainability, evaluate economic, social, and environmental impacts, offer valid explanations, and make reliable predictions.
- The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation.
- Science informs public debate and is in turn influenced by public debate; at times, there may be complex, unanticipated variables or insufficient data that may limit possible conclusions.

Part A: Article Stimulus

Read the article and makes notes (a table would work well here) on: the biology, the technology, historical perspectives of the innovation, future directions, issues or problems with the technology, implications for use.

Use the internet and other sources of information to do more research on the information that you have made notes about. Consider the Biology you need to know, the scientists involved in this work, cost or other factors associated with the use and distribution of this technology, the other disciplines involved in the technology, the impact of this technology, any limitations associated with the new possibilities, and any other information that may be relevant.

Search for articles, data, or other information that you could use to support your discussion in your report. Record the resources in a reference list, using Harvard Referencing, for future reference.

Show your teacher your initial findings, the annotations, and notes (or table) about the article

Due Date: _____

Part B: Links to the SHE key concepts

Chose **at least one** of the SHE key concepts listed above and link the information you have gathered in Part A to these key concepts. Consider how the key concept(s) is demonstrated, what information is still needed, draw conclusions about how human ingenuity and application of knowledge has enabled this technology to become a reality.

e.g. Advances in scientific understanding in one field can influence and be influenced by other areas of science, technology, engineering, and mathematics

The bionic finger would not be able to have been designed, if prosthetic limbs had not been already designed and developed, or if surgical advances had not enabled nerves to be connected artificially etc.

Show your teacher the links you have made to the SHE key concepts chosen. This may be in the form of a table, a concept map, or any other format that helps you to make your ideas clear.

Date Due: _____

Part C: Report Planning

Search for any further information that will enable you to provide a comprehensive and detailed report, with highly relevant biology as determined by the planning in Part A and B.

This will also assist you to justify your conclusions and show how they relate the SHE key concept(s) chosen.

Record the resources in a reference list using Harvard Referencing.

Plan your report. This will be submitted to your teacher for feedback.

Date Due: _____

Note: Part A and B and C are not included in the word count.

Part D: Scientific Communication: Report

Use the information and data gathered to write a report providing an analysis of the interactions between science and society that led to the development of the "Bionic Finger".

Your report *must* include:

- An introduction, which links the focus of your analysis to the SHE key concept(s) chosen
- An explanation of how the focus of the investigation and key concept(s) illustrate the interaction between science and society
- Relevant biological concepts and background information ***(this should support your report but not be the focus)***
- A discussion of the potential impact or application of the focus to past and current users, future developments or the ethical and social considerations
- A conclusion and justification. You must include in your justification how the SHE key concept(s) has been addressed.
- In text referencing and Reference list using Harvard Referencing

See also Appendix I for further suggestions on suggestions on how to link the SHE key concepts to biology/science and its interaction with society.

Assessment Conditions:

4 weeks to complete. Class time provided for research and support.

Students may submit one draft of the final report for feedback. This does not include the checkpoints and plans.

Verification of student work will occur throughout the task.

Word Count: maximum of 1500 words for Part D or 10 minutes for an oral presentation.

Assessment Design Criteria

Investigation, Analysis and Evaluation: IA 3

Knowledge and Application: KA 1, 3, 4

Due date for final report: _____

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed biological investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of biological concepts. Develops and applies biological concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of biology coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear biological investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of biological concepts. Develops and applies biological concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of biology mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear biological investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of biological concepts. Develops and applies biological concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of biology generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of a biological investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of biological concepts. Develops and applies some biological concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic biological information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a biological investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of biological concepts. Attempts to develop and apply biological concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about biology.

Bionic finger can feel textures

sensation of texture where the index finger of his amputated arm had been. He could distinguish between surfaces 96 per cent of the time.

"It was very close to the feeling in my real arm – you can feel

will take time to develop electrodes that can stay in the body for long periods.

Micera's team also tested the bionic finger on four non-amputees using a single electrode inserted into the upper

surgically inserted electrodes. The patterns of stimulation emulate those that happen naturally when you run your

Once more, with feeling

amputees to experience the things you would touch in the real world, like the texture of jeans. ■

Note that schools may have a subscription to New Scientist that enables students to log in and read a similar article online:

https://www.newscientist.com/article/2079808-bionic-fingertip-gives-amputee-a-feel-for-different-textures/

Appendix I: Possible exploration of SHE key concepts

SHE key concept	Possible exploration
Communication and Collaboration	This may include • a discussion of the contribution of individuals, teams or organisations that were involved in the discovery of prosthetics, the bionic finger • how communication in the scientific community, in various forms may contribute to the development of new or improved technology
Development	This may include • an evaluation of the development of the technology from the earliest of prosthetics to current applications • the development of sensors that enable touch to be distinguished, how this relies on the biology, knowledge and understanding of the nervous system
Influence	This may include • how one scientific discipline or engineering, technology or mathematics may impact the development of improved prosthetics with the sense of touch • discuss the economic, social, environmental, ethical and cultural influences on the availability and use of these technologies • consider the ethical issues around the use of these technologies, also consider accessibility
Application and Limitation	This may include • how scientific knowledge can enable scientists to develop solutions for humans to have better lives • consider the economic and social impact of this technology • the application of this technology to other human sense deficiencies e.g. hearing or sight etc. • the impact on the user of this technology

Note for teachers:

Part A, B and C are not included in the 1500 word count.

Appendix 1 is provided as an additional support material for this task and should not be used as a checklist. Teachers should encourage students to widely explore the possible SHE key concepts involved.

While the biology and science involved will be a part of the report it should not be the focus. The assessment focus should be on the student's ability to explore and connect the interaction between science and society.

Stage 2 Biology - Program 2: 20-credits

This teaching program articulates with learning and assessment plan 2.

Week	Science Understandings	SIS	SHE	Assessment Tasks
Term 1 Week 1	• Cell Theory • Prokaryotic and Eukaryotic cells –comparison • Eukaryotic cells- internal organisation/organelles • Compare plant / animal cells	• Microscopes • Electron-micrographs of organelles		
2	• DNA: structure and function, location, prokaryotic vs eukaryotic • DNA replication	• Construct models of DNA • Extract DNA • Use DNA models to simulate DNA replication • Watch animations	Look at the how information from a number of scientists have contributed to the current model of DNA	

3	• Genes
	• Coding and Non-coding DNA- introns and exons
	• Proteins:
	  • What is a protein?
	  • Polypeptide Folding = functional protein
	  • 3-D shape- importance and how it forms
		• Model the folding of a polypeptide		

4	• Proteins: structure and function (hormones, receptor proteins, antibodies)
	• Enzymes
	  - Specific
	  - Catalysts
	  - Induced Fit model
	  - Factors that affect enzyme function
		• Investigate the effect of a factor on enzyme activity		

5	• Protein Synthesis	• Model the processes of transcription and translation		
6-7	• Phenotypic Gene Expression • Cellular differentiation • DNA methylation • Epigenetic modifications can lead to cancer.	Watch video	Explore diseases associated with epigenetic changes	
8	• DNA Mutations (include the science understandings from Topic 4) • DNA sequencing • PCR	• Experiment: PCR (simulation) or visit a lab		**Begin: SHE Investigation**
9	• Biotechnology: genetic engineering		Compare traditional selective breeding with cloning	
10	• Transferring DNA • New technologies: such as CRISPR to edit/transfer genes • Benefits and Limitations		Consider the ethical consideration of new technologies and gene technology	

Week	Science Understandings	SIS	SHE	Assessment Tasks
11	• Review • Introduce next topic: Cells continued.			**Summative SAT 1: Test 1**
Term 2 Week 1	• Energy and Cells (links to all the processes discussed in Term 1) • Autotrophs and Heterotrophs • Compare these groups • Inputs and Outputs			**Summative: SHE Investigation Due**
2	• Photosynthesis • Aerobic Respiration • Anaerobic Respiration	• Investigation: Practical – use a data logger to measure photosynthesis or respiration (anaerobic)		**Summative: Practical Investigation: Factors that affect photosynthesis or respiration**
3-4	• Transport in Cells • Structure and Function of the Cell Membrane • Fluid Mosaic Model • Explain how the membrane facilitates different transport processes • Factors that affect transport	• Model of the cell membrane • Investigation: factors that affect diffusion or osmosis		
5	• Cell Metabolism			
6	• Cell Division: • Binary Fission: Prokaryotic cells	• Watch videos to visualise the different processes of cell division		
7-8	• Mitosis: Eukaryotic cells • Cell Cycle • Cell Culture • Carcinogens/Cancer	• Microscopes: prepared slides or onion root tips • Use models to learn the stages of mitosis	Discuss example of contemporary uses of cell culture	
9	• Meiosis: production of gamete cells: Eukaryotic cells	• Use models to learn the stages of meiosis • Model crossing over and independent assortment		
10	• Review			**SAT 2: Test 2**
Term 3 Week 1	• Introduction to Homeostasis: tolerance limits • Nervous and Endocrine Systems – compare functions, work together • Composition of the Nervous System • Role of the neurons • Neuron Pathways (synapse, neurotransmitters).	• Investigation: tolerance limits of organisms – use seedlings to test salinity, pH, etc. • Investigate: Reflex responses (use online reflex tests)	Video: Extreme Microbes	
2	• Stimulus Response Model/Negative Feedback • Reflex responses • Composition of Endocrine system in Humans	• Investigate the effect of plant hormones on plant growth		

Week	Science Understandings	SIS	SHE	Assessment Tasks
3-4	• Hormonal and Nervous system action in body temperature, blood glucose, metabolism, carbon dioxide and osmoregulation			
5	• Role of hormonal imbalances in diabetes			
6	• Introduce: Evolution • The beginning of life on Earth • Prokaryotic cells existed before Eukaryotic cells			Article for Non-Test SAT given to students
7	• Species: Definition and limitations of • Reproductive isolating mechanisms • Comparative Genomics and associated techniques • Phylogenetic Tree Diagrams	• Compare sequences of DNA and amino acids • Practical: Gel electrophoresis		Non Test: SAT 4 Article Task
8	• Gene Pools • Natural Selection • Genetic Diversity	• Simulation: Pepper Moths	Discuss the work of Darwin and Wallace in the development of the theory of Natural Selection. Link to SHE development of models	**Deconstruct and Design Practical Investigation: Natural Selection (predation)**
9	• Speciation • Allopatric Speciation • Convergent Evolution • Adaptive Radiation • Succession	• Look at examples for each of these types of speciation processes • Examples of succession- video or photographs or schematic		
10	• The effects of Humans • Maintain biodiversity		Discuss extinctions, role of humans in preservation of species/habitats	**SAT 3: Test 3**

Stage 2 Biology (20-credits)

Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio **Weighting 30%**	Students design and implement a practical investigation related to **Topic 2: Cells as the Basis of Life**. Students use their knowledge to design a method to investigate the effects of a factor on photosynthesis (respiration next year). Students individually design an investigation with an appropriate method, hypothesis and variables. They record and present data using appropriate terms and conventions. Students evaluate procedures and discuss their effects on the data collected. Correct use of biological terminology is assessed.	1, 2,3,4	1, 4	Class time will be given for students to individually design the investigation question/hypothesis. A double lesson to undertake the practical in an allocated group of students. Each student submits a practical report according to the guidelines in the subject outline. Students may submit one draft for feedback Word Count: maximum of 1500 words or 10 minutes for an oral presentation for the introduction, analysis, evaluation and conclusion sections of the report.
	Students deconstruct a problem, design a method and implement a practical investigation related to **Topic 4: Evolution**. They simulate the concept of Natural Selection. Students investigate predation and natural selection using a model. They will develop a method, by testing and considering a range of questions, that is based on one that has been provided. They identify an appropriate hypothesis and variables and complete the practical, recording and presenting data using appropriate terms and conventions. Students evaluate procedures and discuss their effects on the data collected. They justify their conclusions. Correct use of biological terminology is assessed.	1, 2,3,4	1	Class time will be given for students to individually design the investigation question/hypothesis. A double lesson to undertake the practical in an allocated group of students Each student submits a practical report according to the guidelines in the subject outline. Students may submit one draft for feedback Word Count: maximum of 1500 words or 10 minutes for an oral presentation for the introduction, analysis, evaluation and conclusion sections of the report.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
	The Science as a Human Endeavour Investigation enables students to demonstrate a comprehensive understanding of an aspect of, or context related to any of the topics in Stage 2 Biology**.** The focus of this task is for a student to research an aspect of Biology with a particular emphasis on how humans interact with and use biological knowledge. Students will select at least one aspect of the Science as a Human Endeavour key concept described on page 45 and 46 of the subject outline as a basis for their chosen aspect or issue. Students choose a focus, access information from different sources, select and acknowledge appropriate sources to support their own conclusions. They will need to logically link their knowledge of Biology to the aspect chosen. They do detailed and deep research to analysis and evaluate the aspect of Biology chosen for the task. Students may choose the format of their report: either an article for a scientific journal, a written report providing an expert's point of view, an analysis of a new development in a field or a concern about a change which has economic, social, environmental or political implications.	2, 3	1,3,4	4 weeks to complete. Class time provided for research and to support students. Students will submit a focus and plan for review by the teacher. Verification of work will occur as the student undertakes research and planning. Students may submit one draft for feedback Word Count: maximum of 1500 words or 10 minutes for an oral presentation.
Assessment Type 2: Skills and Applications Tasks **Weighting 40%**	Students demonstrate Biological knowledge and skills from **Topic 1: DNA and Proteins** and **Topic 2: Cells as the Basis of Life**. The content of the task covers key concepts from any aspect of the topic taught. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They solve problems, and interpret data or diagrams. Questions include those in which students use science inquiry skills to provide an answer. An extended response question is included. Correct use of biological terminology is assessed.	1,2,3	1,2,4	Supervised written assessment. Total Time: 90 minutes + 5 minutes reading time.
	Students demonstrate Biological knowledge and skills from **Topic 2: Cells as the Basis of Life**. The content of the task covers key concepts from any aspect of the topic. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They apply their knowledge, solve problems, and interpret data or diagrams. An extended response question is included. Some questions require students to use science inquiry skills to provide an answer. A number of questions address aspects of Science as a Human Endeavour. Correct use of biological terminology is assessed.	3, 4	1, 2, 3	Supervised written assessment. Total Time: 90 minutes + 5 minutes reading time.
	Students demonstrate Biological knowledge and skills from **Topic 3: Homeostasis** and **Topic 4: Evolution.** The content of the task covers key concepts from any aspect of the topics. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They apply their knowledge, solve problems, and interpret data or diagrams. Questions include those in which students use science inquiry skills to provide an answer. A number of questions address aspects of Science as a Human Endeavour. An extended response question will also be included. Correct use of biological terminology is assessed.	2	1,2,3,4	Supervised written assessment. Total Time: 90 minutes + 5 minutes reading time.
	Students demonstrate their deep and broad knowledge and understanding of a range of biological concepts linked to Topic 1, 2 and 4 by answering a series of questions. Using a scientific article as the initial source of information, students will apply their knowledge in a new context, undertake additional research to demonstrate a deeper understanding, and explore some of the key concepts of Science as a Human Endeavor revealed in the article provided. In addition, students will provide evidence of their science inquiry skills by designing a detailed investigation (which will not be performed).	1	1,2,3	Students will be provided with the article a week before the classroom session. Students will then be given class time (90 minutes), to answer questions relating to the article, SHE and designing an investigation. This is a supervised task; however, students will have access to any resources required, including internet access. This will be an online task.
External Examination Weighting 30%	2-hour examination	All specific features of the assessment design criteria for this subject may be assessed in the external examination. Questions of different types cover all Stage 2 topics and the science inquiry skills. Some questions may require students to integrate their knowledge from more than one topic and show an understanding of science as a human endeavour.		

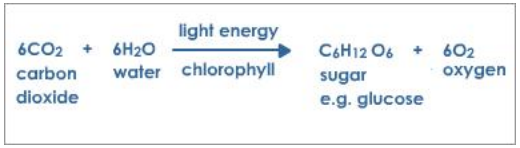
Eight assessments including the external examination. *Please refer to the draft Stage 2 Biology subject outline.*

Stage 2 Biology: Investigation Folio Task 1
Topic 2: Cells as the Basis of Life
Design Task: Effect of various factors on Photosynthesis

Introduction and Purpose of Task:

Photosynthesis a vital process that converts light energy from the sun into chemical energy in the form of glucose. Organisms that have chlorophyll or other related pigments are able to undertake this process and are said to be "photosynthetic".

Photosynthesis can be represented by the reactions:



Factors that affect photosynthesis could include: the concentration of carbon dioxide, availability of water, presence or absence of light, light frequency, and the concentration of chlorophyll.

In this task, students will design an investigation to determine how one factor could affect photosynthesis.

Part A: Research and Design your own experiment

There are many different methods that can be used to investigate photosynthesis, both provided by the teacher and those you find yourself. Use these to help you to design an experiment to test the effect of your chosen factor on photosynthesis.

Keep a list of references used to design your method.

Please note: this task provides an opportunity to use data loggers to collect the data, if the equipment is available.

1. Design your experiment individually to test one factor that could affect photosynthesis. In your design include all details required to undertake a reliable and valid experiment. You must also consider the safety aspects of this experiment. Reference your information appropriately.
    a. Variables, measurement of the dependent variable, one independent variable, constant variables
    b. Hypothesis
    c. Materials and Equipment required
    d. Method suitable to test the hypothesis

This is handed up before the investigation is undertaken.

Due date: _____

Part B: Complete the experiment

1. Your teacher will allocate you into groups to undertake one experiment designed by one of your groups' members or another appropriate method. This design will be chosen with your teacher, based on equipment availability and feasibility.
2. You will complete the experiment and record the data in an appropriate results table.
3. You will write the report, with the discussion component focused on the data collected.

The Investigation Report must include: (needs to be an individual report)

[Aspects in bold font are **included** in the word count of the report]

An appropriate introduction – introduces the theory behind the practical

Aim: what is the purpose of the experiment?

Part A: Design Component:

Hypothesis, Identification of all the variables

Materials and Method with Safety Considerations

Reference List (Harvard Referencing System)

Part B: Completion Component:

Hypothesis suitable to experiment that was undertaken

Results Table(s) and Graph(s)

Discussion- includes analysis of the data and evaluation of the method and data, and suggestions for improvements to the method

Conclusion- relates to the data

Assessment Conditions for this task:

Class time will be given for students to individually design the investigation question/hypothesis.

A double lesson to undertake the practical in a group. Each student to submit a practical report.

Students may submit one draft for feedback, due one week after the experiment is completed.

Word Count: maximum of 1500 words or 10 minutes for an oral presentation for the **introduction, analysis, evaluation and conclusion** sections of the report.

Final copy is due 2 weeks after the experiment is completed.

Assessment Design Criteria

Investigation, Analysis and Evaluation: IAE 1, 2, 3, 4 Knowledge and Application: KA1, 4

Guidelines for how to address the Performance Standards in the report:

Section of the Report	Requirements/Indicators	Specific Feature
Introduction	Relevant biological Information presented that relates specifically to the practical being investigated. The information relates to the aim of the experiment.	KA1
Aim	Has the correct format Indicates the purpose of the experiment Independent and dependent variables are identifiable.	KA1
Hypothesis	Has the correct format- is not in the form of a question Links the independent and dependent variable and is a prediction.	IAE1
Method	Describes how the independent variable is changed, is detailed and describes how the dependent variable is measured. All variables should be identified, how and why they are controlled	IAE1
Results	Table has the correct format Data is represented in an appropriate manner- all data is shown Significant figures are correct Graphs are drawn appropriately- axis are labelled, appropriate scale used, title, size, correct format	IAE2
Discussion	Explains all the data obtained Provides reasoning based on the data for supporting or rejecting the hypothesis Identifies potential sources of random and systematic error specifically Discusses the data's reliability, precision, accuracy and validity Evaluates the experimental method and suggests possible relevant improvements to the design of the experiment	KA1, IAE3 IAE4
Conclusion	Indicates whether the aim of the experiment has been met and restates the overall trend of the experiment.	IAE3
Safety Audit	Detailed analysis of the potential risks, hazards and how they are managed and the precautions taken in the classroom	IAE1
Communication	Use of appropriate biological terms and conventions	KA4
Reference List	Harvard Referencing Used Sources correctly cited. Bibliography provided	KA4

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed biological investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of biological concepts. Develops and applies biological concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of biology coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear biological investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of biological concepts. Develops and applies biological concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of biology mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear biological investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of biological concepts. Develops and applies biological concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of biology generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of a biological investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of biological concepts. Develops and applies some biological concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic biological information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a biological investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of biological concepts. Attempts to develop and apply biological concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about biology.

Stage 2 Biology: Investigation Folio Task 2

Topic 4: Evolution

Deconstruct and Design Task: Predator-Prey Relationships and Natural Selection Simulation Investigation

Introduction and Purpose of Task:

Predators consume other organisms that are considered their prey. These relationships in nature are important. The predator will not survive if it does not have a food source, while the predator controls prey numbers so that it too can survive within the ecosystem they share.

Predators and their corresponding prey evolve together, so that they each have specialised adaptations that enable the survival of both species.

Natural Selection enables individuals of a population to survive if they have the characteristics that make them the most suitable to the prevailing environmental conditions. These organisms then reproduce and pass on these favourable characteristics to offspring. This alters the gene frequency of characteristics that are favoured.

In this task, students will design an experiment to investigate: a factor that affects the ability of an organism to survive how predation may affect a population of prey, an experimental model and evaluate it and to observe natural selection in a simulated exercise.

Part A: Deconstructing the Problem to develop an appropriate method:

Preparation of the location and testing

Teachers please note: This practical requires preparation and an appropriate location(s). It is a practical that requires several weeks to undertake. In addition to deconstructing a problem, it is also an opportunity for students to consider the ethical and safety consideration of a practical that uses real organisms in a field setting.

Things for students to deconstruct and consider include:

Collection of data - as it is ideal to collect data daily.

Best time of the year to do this experiment?

Best Location? Types of Birds?

Safety considerations: the use of food dye in foods fed to organisms in the location – use food grade dyes, these are safe for consumption

Live birds and other animals may be encountered, and certainly their waste will be. Use gloves.

Working outside, consider sun safety and the environmental conditions.

Preliminary Investigation: To determine the best location

1. Look around the school grounds for a location that has birds naturally.
2. Consider the safety of this location.
3. Consider the natural predators or other organisms in the area- will these also be attracted by the food source?
4. If no location is suitable, set up a bird table in an appropriate location.

Materials and Method:

Web cam*
Wild bird food
Spaghetti
Food colouring

1. Acclimatise the local bird population by providing food in the same area as the experiment to be undertaken.
2. Observe the birds, habits, identify if possible. Use of a web cam if available could assist with this and for data collection later in the experiment.
3. Feed the birds for **at least one week**, to ensure they keep returning.

Making the Spaghetti Worms (when ready to start the actual experiment)

a. Cook spaghetti as per instructions
b. Add dye to the cooking water. Food grade dyes are not dangerous to birds.
c. E.g. Green = 15ml of bright green dye, 5 ml of black and 10 ml of red = red/brown etc.
d. They can be kept in the fridge for 3 days or stored in the freezer and thawed before use.

Method for Investigation (you will need to alter this, based on your independent variable):

1. Select and mark out the feeding area according to the acclimatisation trials.
2. Present equal numbers of "different" spaghetti worms to the birds.
3. Each day, count the number of worms remaining of each type.
4. Make a new population, the size of the original, but with fresh worms of each type in proportion to the numbers of each type you collected.

Calculation to determine population after each predation cycle:

Total number of worms in starting population = N

Number of worms of type A collected = a

Number of worms of type B collected = b [do this for each different type]

Total number of worms collected = (a + b + ….) = n

Number of worms of type A to be put out for next generation = a x N ÷ n [calculate for each type]

Part B: Design your own experiment

1. Design your experiment individually to test one factor on the predation of the spaghetti worms. In your design include all details required to undertake a reliable and valid experiment. You must also consider the safety aspects of this experiment.
   a. Variables, measurement of the dependent variable, one independent variable, constant variables
   b. Hypothesis
   c. Materials and Equipment required
   d. Method suitable to test the hypothesis- consider the number of spaghetti worms, the distribution of the worms.
   e. Results collection and presentation
2. In defined groups, students in consultation with the teacher will select one method to perform and to collect data.
3. Individually write a practical report.

Factors that could be investigated include: different colour prey, different length or size prey, different areas, different shaped prey.

The Investigation Report must include: (needs to be an individual report)

An appropriate introduction – introduces the theory behind the practical

Aim: what is the purpose of the experiment?

Hypothesis, Identification of all the variables

Materials and Method with Safety and Ethical considerations: This will be detailed to include the deconstruction of the problem that led to the method designed by the student.

Results Table(s) and Graph(s)

Discussion- includes analysis of the data and evaluation of the method used (which may not be the one designed by the student, depending on the feedback from the teacher).

Consider the following (not limited to this): Why use a model? What do the worms represent? How does the use of the model differ from real predator-prey relationships? Sources of uncertainty? Reliable? Accurate?

Conclusion- relates to the data and must be justified. What limitations are associated with the conclusion?

Reference List (Harvard Referencing System) - not assessed in this task, but required.

Reflection: How has the model assisted in your understanding of Natural Selection?

Assessment Conditions for this task:

Class time will be given for students to individually design the investigation question/hypothesis.

Numerous lessons will be provided to set up and undertake the practical in a group. Ongoing-collection of data will be arranged.

Each student will submit an individual practical report. Students may submit one draft for feedback, due one week after the collection of the data is completed.

Word Count: maximum of 1500 words or 10 minutes for an oral presentation for the **introduction, analysis, evaluation and conclusion** sections of the report.

Final copy is due 2 weeks after the experiment is completed.

Assessment Design Criteria IAE 1, 2, 3, 4 KA1

Refer to your *Guidelines for how to address the Performance Standards a practical report* to help you write your report.

References:

"I'm a worm, get me out of here", Wellcome Trusts, Darwin 2000
A model for Natural Selection- spaghetti worms, Nuffield Foundation.org.

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed biological investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of biological concepts. Develops and applies biological concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of biology coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear biological investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of biological concepts. Develops and applies biological concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of biology mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear biological investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of biological concepts. Develops and applies biological concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of biology generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of a biological investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of biological concepts. Develops and applies some biological concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic biological information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a biological investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of biological concepts. Attempts to develop and apply biological concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about biology.

Stage 2: Non-Test SAT Biology Task

Background of Task:

Students have the opportunity to use their knowledge to demonstrate a deep and broad understanding of a range of biological concepts linked to Topic 1, 2 and 4 by answering a series of questions. Using a scientific article as the initial source of information, students will have the opportunity to apply their knowledge in a new context, do additional research to demonstrate a deeper understanding, to explore the Science as a Human Endeavor links within the article provided. In addition, students will provide evidence of their science inquiry skills by designing a detailed investigation (which will not be performed).

Topics included:

Topic 1: DNA and proteins, Topic 2: Cells as the Basis of Life, Topic 4: Evolution

Assessment Conditions:

The article will be provided a week before the written aspect of the task. This will enable students to read the article and to consider the biology, do some initial additional research and ensure they understand the contexts included.

Article: Sole, R, "Back from the Brink", New Scientist, 1 October, 2016 pp 36-37.

https://www.newscientist.com/article/mg17123071.800-back-from-the-brink/

(Note that schools may have a subscription to New Scientist that enables students to log in and read the article online)

Students will then be given class time (90 minutes), to answer questions relating to the article, SHE and designing an investigation.

This is a supervised task; however, students will have access to any resources required, including internet access.

This will be an online task.

Assessment Design Criteria:

Investigation, Analysis and Evaluation: IAE1 Knowledge and Application: 1, 2, 3

Instructions for Students

Part A (to be completed in the student's own time and before the lesson that has been scheduled for Part B to be undertaken)

Read the article provided/online.

Undertake research to ensure that you fully understand the ideas and concepts presented in the article. Consider how these relate to the interaction between science and society.

Part B (to be completed in supervised lesson time)

Answer all of the following questions in the space provided:

1. Explain, using examples from the article, why this article was titled "Back from the Brink"?
2. Many new solutions to solve the problems of ecosystem destruction were outlined in the article. What would be the **benefit** to organisms and humans of these solutions if they were used in a damaged ecosystem?
3. Explain why organisms may not survive if they are put into new environments.
4. Describe how bacteria could be engineered to produce a water-trapping polymer.
5. Consider the following key concepts of Science as a Human Endeavor and link your knowledge, your research, and the information from the article to write a response to explore and understand the interaction of society and science.

   Application and Limitation:

   - Scientific knowledge, understanding, and inquiry can enable scientists to develop solutions, make discoveries, design action for sustainability, evaluate economic, social, cultural, and environmental impacts, offer valid explanation, and make reliable predictions.
   - The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation.

6. Investigation design.

   Choose **one** of the following investigations and design a logical, coherent and detailed method to test a hypothesis.

   Design and experiment to determine

   a. the best way to improve/enhance moisture retention in soil

      or

   b. if detergents labelled as "biodegradable" or "environmentally safe" are actually better for the environment?

      or

   c. whether soil productivity can be improved by adding bacteria?

   You will need to include:

   - a hypothesis
   - dependent and independent variables
   - factors held constant (how and why they are controlled)
   - factors that may not be able to be controlled (and why not)
   - materials required
   - the procedure to be followed
   - the type and amount of data to be collected
   - identification of ethical and safety considerations.

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed biological investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of biological concepts. Develops and applies biological concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of biology coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear biological investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of biological concepts. Develops and applies biological concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of biology mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear biological investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of biological concepts. Develops and applies biological concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of biology generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of a biological investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of biological concepts. Develops and applies some biological concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic biological information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a biological investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of biological concepts. Attempts to develop and apply biological concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about biology.

Stage 2 Biology Year Program 3: Topics Integrated

Articulates with LAP 3

Week	Science Understanding	Science Inquiry Skills	Science as a Human Endeavour	Summative Assessment Tasks
Term 1				
1	Life on earth, how for how long? Concept and definition of Evolution Existing cells are the product of evolution			
2-4	Prokaryotes vs Eukaryotes- compare Cell Theory Cell Structure: Cell Membrane- Fluid Mosaic Model Organelles (structure and function, arrangement of internal membranes) Compare plant and animal cells	Microscopes Electron micrographs of organelles Model of the cell membrane	Discuss developments of different microscope technology and change in understanding. (Influence)	
5	Endosymbiotic theory to explain evolution of Eukaryotes Role of membrane, ribozymes in the first simple cells			
6	DNA: Compare structure in prokaryotes and eukaryotes. DNA molecule: structure and function DNA replication	Construct models of DNA Extract DNA Use DNA models to simulate DNA replication Watch animations	Discuss how information from a number of scientists have contributed to the current model of DNA (Communication and Collaboration)	
7	DNA mutations- genetic variation, source of new genes, what can increase the mutation rate Genes: introns and exons		How does an understanding of the causes of mutation affect work health and safety? (Influence)	
8	Protein synthesis	Model the processes of transcription and translation		
9	Comparative Genomics: techniques Species definition(s)	Compare sequences of DNA (and amino acid)	The Power of Comparative Genomics You tube. How can it be applied? (Application) How has the understanding changed since this was produced? (*Limitations*)	Summative SAT 1: Test
10	Phylogenetic trees: draw and interpret -more closely related species share more similarity in their DNA sequences	Do practice exercises drawing simple phylogenetic trees	What is the interaction between mathematics and phylogenetic trees?? (*Influence*) NIMBios video	Begin SHE Investigation
11	Reproductive Isolation: pre and post zygotic			
Term 2				
1-2	Sources of variation in sexually reproducing species: Cell division:, mitosis, meiosis (including crossing over and independent assortment) Fertilisation	Watch videos to visualize the different processes of cell division Microscope: Look at prepared slides of onion root tips Use models to learn the stages of mitosis		
3	Asexual and Sexual reproduction Binary fission Compare mitosis/meiosis Somatic vs Germ Line cells Control of cell division- features of and role of hormones Uncontrolled cell division	Use models to learn the stages of meiosis Model crossing over and independent assortment	Discuss recent developments and understanding of uncontrolled cell division at its treatment (*Development, Application and Limitation*)	
4	Cell culture: applications and limitations/benefits and harmful effects of chemicals.		Discuss examples of contemporary uses of cell culture (*Application*)	Summative: SHE Investigation Due
5	Introduce homeostasis- discuss tolerance limits Introduce the Nervous System: compare structure and function of neurons, role of receptors, receptor to effector, synapses and neurotransmitters.	Investigation: tolerance limits of organisms- use seedlings to test salinity, pH etc. Investigate: reflex responses (use online reflex test)	Video: Extreme microbes	
6	Compare the nervous and hormonal system and discuss their interdependence. Stimulus Response Model: reflex arc and negative feedback.			

Week	Science Understanding	Science Inquiry Skills	Science as a Human Endeavour	Summative Assessment Tasks
7-8	Discuss in detail the following homeostatic examples: Body Temperature (Thyroxine) Osmoregulation (ADH) Carbon Dioxide in Blood Fight or Flight response (adrenaline) Blood sugar (insulin/glucagon) Diabetes and hormonal imbalance		http://www.news.com.au/lifestyle/health/health-problems/new-device-for-diabetes-eliminates-the-need-for-painful-finger-pricking/news-story/539d9044155f4866ce7e41b770844001 Discuss article. (*Collaboration*, *Development*, *Influence*)	
9	Proteins: structure (primary, secondary, tertiary, quaternary), structure to function relationship. E.g. enzymes, some hormones etc.	Model folding of a polypeptide		
10	Enzymes: induced fit, factors, role in cell metabolism Revisit protein synthesis and consider phenotypic expression and cellular differentiation.	Investigate the effect of a factor on enzyme activity (deconstruct and outcomes uncertain as a focus)	Discuss uses of enzymes in food, cleaning, treatments. (*Application*)	Summative SAT 2: Test (SIS and Science Understanding)
Term 3				
1	Gene Expression Epigenetic changes	Watch video	Explore disease associated with epigenetic changes (*Application and Limitation*)	
2-3	Genetic engineering and associated techniques: DNA sequencing, PCR, revisit DNA profiling. Issues (ethical, economic and cultural) re genetic information collection	Experiment: PCR simulation or visit a lab	Compare traditional selective breeding with cloning (*Application and Limitation*)	
4	Tools of genetic engineering: plasmids, bacterial enzymes, gel electrophoresis, bacterial transformation, PCR, probes/restriction enzymes.	Practical: Gel Electrophoresis		
5	New technologies: CRISPR, benefits and limitations of CRISPR + CAS and other.		Consider the ethical considerations of new technologies and gene technology (*Development*)	

Week	Science Understanding	Science Inquiry Skills	Science as a Human Endeavour	Summative Assessment Tasks
6	Energy: autotrophs vs heterotrophs, photosynthesis, cellular respiration (compare aerobic/anaerobic etc.) ATP cycle	Investigation: Practical- use a data logger to measure photosynthesis		Summative Practical Investigation: Design Factors that affect respiration.
7	Obtaining substances for survival: transport processes, revisit cell membrane, factors that affect transport	Investigation: factors that affect diffusion or osmosis		Summative SAT 3: Test (SHE and Science Understanding)
8	Chance of survival: concept of a gene pool Natural Selection: role of variation, low genetic diversity, consequences and examples.	Simulation: Pepper Moths	Discuss the work of Darwin and Wallace in the development of the theory of Natural Selection (*Communication*)	Deconstruct and Design, outcome uncertain Investigation: Natural Selection Simulation (Predation)
9	Speciation: genetic drift, geographical isolation and allopatric speciation Compare allopatric and sympatric speciation Convergent evolution Divergent (adaptive radiation) Extinction and Human Activity, ethical considerations.	Look at examples for each of these types of speciation.	Discuss extinctions and the roles of humans in preservation of species/habitats. (*Application and Limitation, Influence*)	
10	Succession	Examples of succession- visit a site or look at photographs or watch a video.		Summative SAT 4: Non-test SAT- Article and response
Term 4				
1-2	Revision – past exam questions	Deconstructing problems	Responding to SHE questions	

Stage 2 Biology (20-credits)

Articulates with Program 3

Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio **Weighting 30%**	Students design and implement a practical investigation related to **Topic 2: Cells as the Basis of Life**. Students use their knowledge to design a method, for which the outcome is uncertain to investigate the effects of a factor on respiration. Students individually design an investigation with an appropriate method, hypothesis and variables. They record and present data using appropriate terms and conventions. Students evaluate procedures and discuss their effects on the data collected. Correct use of biological terminology is assessed.	1, 2,3,4	1, 4	Class time will be given for students to individually design the investigation question/hypothesis. A double lesson to undertake the practical in an allocated group of students. Each student submits a practical report according to the guidelines in the subject outline. Students may submit one draft for feedback Word Count: maximum of 1500 words or 10 minutes for an oral presentation for the introduction, analysis, evaluation and conclusion sections of the report.
	Students deconstruct a problem, design a method and implement a practical investigation related to **Topic 4: Evolution**. They simulate the concept of Natural Selection. Students investigate predation and natural selection using a model. They will develop a method, by testing and considering a range of questions, that is based on one that has been provided. They identify an appropriate hypothesis and variables and complete the practical, recording and presenting data using appropriate terms and conventions. Students evaluate procedures and discuss their effects on the data collected. They justify their conclusions. Correct use of biological terminology is assessed.	1, 2,3,4	1	Class time will be given for students to individually design the investigation question/hypothesis. A double lesson to undertake the practical in an allocated group of students Each student submits a practical report according to the guidelines in the subject outline. Students may submit one draft for feedback Word Count: maximum of 1500 words or 10 minutes for an oral presentation for the introduction, analysis, evaluation and conclusion sections of the report.
Assessment Type 2: Skills and Applications Tasks **Weighting 40%**	Students explore the interaction between science and society related to a contemporary aspect of Stage 2 Biology. Based on at least one key concept of Science as a Human Endeavour described on page 45 and 46 of the subject outline students choose a focus, access information from different sources, select and acknowledge appropriate sources to support their own conclusions. They logically link their knowledge of Biology to the aspect chosen, undertake detailed and deep research to analysis, and evaluate the aspect of Biology chosen for the task. Students may choose the format of their report: either an article for a scientific journal, a written report providing an expert's point of view, an analysis of a new development in a field or a concern about a change which has economic, social, environmental or political implications.	2, 3	1,3,4	4 weeks to complete. Class time provided for research and to support students. Students will submit a focus and plan for review by the teacher. Verification of work will occur as the student undertakes research and planning. Students may submit one draft for feedback Word Count: maximum of 1500 words or 10 minutes for an oral presentation.
	Students demonstrate Biological knowledge and skills from **Topic 1: DNA and Proteins, Topic 2: Cells as the Basis of Life and Topic 4: Evolution**. The content of the task covers key concepts from any aspect of the topic taught. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They solve problems, and interpret data or diagrams. An extended response question is included. Correct use of biological terminology is assessed.		1,2,4	Supervised written assessment. Total Time: 90 minutes + 5 minutes reading time.
	Students demonstrate Biological knowledge and skills from **1: DNA and Proteins, Topic 2: Cells as the Basis of Life and Topic 3: Homeostasis**. The content of the task covers key concepts from any aspect of the topic. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They apply their knowledge, solve problems, and interpret data or diagrams. There will be a focus on questions that require students to use science inquiry skills to provide an answer. Correct use of biological terminology is assessed.	1,2,3, 4	1, 2	Supervised written assessment. Total Time: 90 minutes + 5 minutes reading time.
	Students demonstrate Biological knowledge and skills from **Topic 1: DNA and Proteins and Topic 2: Cells as the Basis of Life** The content of the task covers key concepts from any aspect of the topics. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They apply their knowledge, solve problems, and interpret data or diagrams. A number of questions address aspects of Science as a Human Endeavour. An extended response question will also be included. Correct use of biological terminology is assessed.	2	1,2,3,4	Supervised written assessment. Total Time: 90 minutes + 5 minutes reading time.
	Students demonstrate their deep and broad knowledge and understanding of a range of biological concepts linked to all topics but with some emphasis on **Topic 4: Evolution** by answering a series of questions. Using a scientific	1	1,2,3	Students will be provided with the article a week before the classroom session. Students will then be given class time

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
	article as the initial source of information, students will apply their knowledge in a new context, undertake additional research to demonstrate a deeper understanding, and explore some of the key concepts of Science as a Human Endeavor incorporated in the article provided. In addition, students will provide evidence of their science inquiry skills by designing a detailed investigation.			(90 minutes), to answer questions relating to the article, SHE and designing an investigation. This is a supervised task; however, students will have access to any resources required, including internet access. *This will be an online task.*
External Examination Weighting 30%	2-hour examination	All specific features of the assessment design criteria for this subject may be assessed in the external examination. Questions of different types cover all Stage 2 topics and the science inquiry skills. Some questions may require students to integrate their knowledge from more than one topic and show an understanding of science as a human endeavour.		

Eight assessments including the external examination. *Please refer to the draft Stage 2 Biology subject outline.*

Science as a Human Endeavour Task

Introduction and Purpose of task:

In this task you will investigate and demonstrate a comprehensive understanding of science as a human endeavour in Biology related to any of the topics in Stage 2 Biology. The focus of this task is to explore an aspect of contemporary Biology with a particular emphasis the interaction between society and, for example, the application and use of biological knowledge, the influence and development of new technologies, or the design of solutions to problems.

You will use and acknowledge a variety of relevant sources to find data and information to support your chosen topic.

You may choose to present your research findings as either an article in a scientific journal, as a written report providing an expert's point of view, an analysis of a new development in a field or a concern about a development that has economic, social, environmental or political implications on any aspect related to any topic in the Stage 2 Biology science understandings.

Your research, findings and outcome should have a focus on **at least one** of the key concepts of Science as a Human Endeavour listed below:

Communication and Collaboration

- Science is a global enterprise that relies on clear communication, international conventions, and review and verification of results.
- International collaboration is often required in scientific investigation.

Development

- Development of complex scientific models and/or theories often requires a wide range of evidence from many sources and across disciplines.
- New technologies improve the efficiency of scientific procedures and data collection and analysis. This can reveal new evidence that may modify or replace models, theories, and processes.

Influence

- Advances in scientific understanding in one field can influence and be influenced by other areas of science, technology, engineering, and mathematics.
- The acceptance and use of scientific knowledge can be influenced by social, economic, cultural, and ethical considerations.

Application and Limitation

- Scientific knowledge, understanding, and inquiry can enable scientists to develop solutions, make discoveries, design action for sustainability, evaluate economic, social, and environmental impacts, offer valid explanations, and make reliable predictions.
- The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation.
- Science informs public debate and is in turn influenced by public debate; at times, there may be complex, unanticipated variables or insufficient data that may limit possible conclusions.

Part A: Information Search and Planning

1. Use the internet and other sources of information to do an initial search related to a topic of Biology that is of interest to you e.g. new DNA technologies, animal conservation or new medicines. Consider the technology, ethics, benefit to humans, costs, environmental concerns etc. of this topic of interest.

2. In a table, make a list of possible topics and related questions or contexts for your scientific communication.

3. Search for articles, data or other information that you could use to support your discussion. Record the resources in a reference list using Harvard Referencing, for future reference. This will assist you in your selection of your final focus.

4. Choose the focus of your work for the scientific communication.

   e.g. use of hormone replacement therapy to reduce the effect of menopause or an analysis of how effective breeding programs are in the conservation of animals.

5. Link your chosen focus to **at least one** of the key concepts of SHE.

   e.g. The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation could be considered when investigating breeding programs as a method of conserving animals.

6. Check the focus you have chosen with your teacher before you proceed.

Date Due: _____

7. Choose the format of your work: an article in a scientific journal, as a written report providing an expert's point of view, an analysis of a new development in a field or a concern about an issue. You might like to formulate a question or statement that relates to your chosen focus and SHE key concept as the heading for your work.

8. Plan your article or report - this will be submitted to your teacher for feedback.

Date Due: _____

Part B: Refinement of Information for your chosen focus

9. Search for any further information that will enable you to provide a comprehensive and detailed report, with highly relevant biology as determined by your plan from Part A.

   This will also assist you in being able to justify your conclusions.

   Record the resources in a reference list use Harvard Referencing.

Part A and B are not included in the word count.

Part C: Scientific Communication

Use the information and data gathered to write an article in a scientific journal, a report providing an expert's point of view, an analysis of a new development in a field or a concern about an issue you have chosen.

Your report *must* include:

- an introduction, to identify the focus of the investigation and the key concept(s) of science as a human endeavour that it links to
- an explanation of how the focus of the investigation illustrates the interaction between science and society
- relevant biology concepts or background (***this should support your report but not be the focus***)
- a discussion of the potential impact or application of the focus of the investigation, e.g. further development, effect on quality of life, environmental implications, economic and/or social impact, influence on human activities, etc.
- a conclusion, with justification
- citations and referencing.

Assessment Conditions:

4 weeks to complete. Class time provided for research and support.

Students may submit one draft of the final scientific communication for feedback. This does not include the checkpoints and plan.

Verification of student work will occur throughout the task.

Word Count: maximum of 1500 words for Part C or 10 minutes for an oral presentation.

Assessment Design Criteria

Investigation, Analysis and Evaluation: IA2, 3

Knowledge and Application: KA1, 3, 4

Note for teachers:

This format of the SHE task provides the student with an opportunity to select a topic and explore the SHE key concepts connected to their chosen topic. Teachers will need to guide students to select topics to enable the focus to be on the aspects of SHE chosen.

While the biology and science involved will be a part of the report it should not be the focus. The assessment focus should be on the student's ability to explore and connect the interaction between science and society.

Part A and B are not included in the 1500 word count.

Performance Standards	Investigation, Analysis and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed biological investigation. Obtains records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effects on data.	Demonstrates deep and broad knowledge and understanding of a range of biological concepts. Develops and applies biological concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of biology coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear biological investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effects on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of biological concepts. Develops and applies biological concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of biology mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear biological investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates some procedures and some of their effects on data.	Demonstrates knowledge and understanding of a general range of biological concepts. Develops and applies biological concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of biology generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of a biological investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of biological concepts. Develops and applies some biological concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic biological information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a biological investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of biological concepts. Attempts to develop and apply biological concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about biology.

Stage 2 Chemistry Program 1 20-credits **Articulates with LAP 1**

Week	Lesson 1	Lesson 2	Lesson 3	Lesson 4
1	Lessons lost: - return to school - assemblies etc		**Subtopic 1.3 Volumetric Analysis** Revise: - concentration units and conversions - stoichiometry problems	Exercises Revise volumetric glassware and titration procedure.
2	**Practical:** (1) Prepare standard solution of Iron(II) ammonium sulfate (2) Dilute commercial H_2O_2 solution.	Standardise $KMnO_4$ solution. Use standardised solution to determine concentration of H_2O_2 in commercial product.	Analyse results - calculations Evaluate procedure: - systematic and random errors - accuracy and precision	**[Subtopic 4.1]** Photosynthesis. Respiration. Carbon cycle Fossil fuels Combustion of carbon-based fuels
3	**Subtopic 1.1: Global Warming and Climate Change** Action of greenhouse gases in maintaining steady atmospheric temperatures. Anthropogenic sources of GH gases. Exercise: Plot data for trends in global concentration of CO_2. Discuss trend.	View (sections of) **An Inconvenient Truth** Discuss causes and consequences of global warming. Discuss thawing of permafrost and impact.	**Investigation (1) - Volumetric Analysis** Determine which of three beverages is most acidic	
4	Role of oceans in maintaining steady concentrations of CO_2 in the atmosphere (revise equilibrium). Ocean acidification and effects on ocean calcifying organisms: coral reefs. Revise pH and calculations from Stage 1.		**Subtopic 1.2: Photochemical Smog** Formation of nitrogen oxides: - natural processes **[Subtopic 4.3]** - combustion in air Formation of ozone from NO_x	Interpret graphs showing concentrations of NO_x, ozone, hydrocarbons in air over a city. Harmful effects of photochemical smog.

5	Use of catalytic converters to reduce NO_x from motor vehicles. **[Subtopic 2.1]** - Energy profile diagrams - Effect of catalyst on reaction rate	Review exercises	**Subtopic 3.1: Introduction** Revise structural formulae, systematic naming of hydrocarbons from Stage 1.	Physical properties of organic compounds: - revise secondary interactions from Stage 1 - consider the polarities of various functional groups
6	**SAT 1: Infographic due**	Exercises: Predict/explain physical properties of compounds given their structural formulae.	**Subtopic 3.2: Alcohols** Occurrence Systematic nomenclature Classification as primary, secondary, tertiary.	Oxidation products of alcohols. **Practical:** Test a range of primary, secondary, tertiary alcohols with acidified potassium dichromate solution.
7	Alcohols as fuels: combustion products complete and incomplete combustion **[Subtopic 4.1]** Advantages/disadvantages of using ethanol as a fuel in place of fossil fuels. Renewable fuels.	**Subtopic 1.4 Chromatography** View Interactive Lab Primer Discuss concepts of chromatography	TLC and R_f Interpret chromatograms	**Practical:** Identification of the analgesic component of an over-the-counter medication.
8	GLC and HPLC Interpret chromatograms	**[Subtopic 2.2: Equilibrium]** Revise reversible reactions. Introduce concept of equilibrium and Le Châtelier's Principle (changes in concentraion)	Ion exchange chromatography **[Subtopics 4.3, 4.2]** Aluminosilicates and zeolites Use of zeolites in water softeners Cation exchange in soils Availability of nutrient cations to plants ⟷	Effect of acidic/saline conditions on soil fertility Release of toxic cations into soil water by acidic conditions ⟷
9	**Subtopic 1.5: AAS** View VEA Chemical Analysis I Discuss concepts Importance in assessment of metal ores in mining.	Using AAS to identity elements in a sample. Using AAS to determine concentration of element in a sample: - construct calibration graphs (revise volumetric glassware, dilution calculations) - use calibration graphs (interpolation, concentration conversions, systematic and random errors)	Exercises: Analyse AAS data Calculations.	**[Subtopic 4.1]** Revise enthalpy and calculations from Stage 1. Calculate quantities of heat evolved per mole, per gram, and per litre for complete combustion of alcohols. Use of calorimetry to determine enthalpy of combustion.

10	**Practical:** Compare the enthalpies of combustion of the first six alcohols. ⟷	⟶	**Subtopic 3.6: Amines** Occurrence. Role of amines in the nervous system Systematic nomenclature	Classification as primary, secondary, tertiary. Amines as bases. Consider lignocaine and use in protonated form.
11	**Subtopic 3.3: Aldehydes and Ketones** Occurrence Systematic nomenclature Formation from appropriate alcohols.	Oxidation products of aldehydes in acidic and alkaline conditions. Use of acidified dichromate solution and Tollens' to distinguish between aldehydes and ketones.	**Practical:** Prepare propanal and test product with Tollens'reagent. ⟷	⟶
12	**Subtopic 3.4: Carbohydrates** Occurrence Definition Classification as mono, di, polysaccharides. Functions of carbohydrates in nature.	Solubility of mono and disaccharides in water. Condensation of monosaccharides to form di and polysaccharides. Hydrolysis of di and polysaccharides.	Equilibrium in solution between ring and chain forms of glucose. **Demonstration:** Tollens' test on a solution of glucose. Discuss results in terms of equilibrium and Le Châtelier's Principle.	**[Subtopic 4.1]** **Practical:** Fermentation of a carbohydrate to produce ethanol.
13	**Subtopic 3.5: Carboxylic Acids** Occurrence Systematic nomenclature Formation from appropriate alcohols.	**Practical:** Investigate odours of a range of carboxylic acids. RCOOH as weak acids: - ionisation in water - reaction with bases.	**Practical:** - Reaction of hydrochloric and ethanoic acids with magnesium, metal oxides and hydroxides, metal carbonates and hydrogencarbonates. - Explain differences in reactivities.	Consider drugs with carboxyl groups (Aspirin, penicillin). Desirability of using the drug in the form of the carboxylate salt.
14	**Subtopic 2.1: Rates of Reaction** Measuring rate by change in concentration, change in mass of system, volume of gas evolved etc.	Collision theory used to explain the effect on rate of reaction of changes in: - concentration of reactant - pressure (gaseous systems) - temperature - surface area - presence of catalyst.	**Practical:** Effect of changing temperature OR reactant concentration on the rate of reaction of sodium thiosulfate and HCl. ⟶	Analyse results. Evaluate procedure.

	Demonstration: Follow the reaction of marble chips with HCl solution over time. - Graph results. - Interpret graph.	Revise energy profile diagrams and catalytic converters. Discuss photocatalysis (UV light on nanoparticles of TiO_2 on surfaces) to remove undesirable solvent vapours from the air.		**Practical Design** Effect of changing a reaction condition on the rate of fermentation of a carbohydrate.
15	**SAT 2: Test**	**Practical Design** Carry out investigation	**Subtopic 2.2: Equilibrium and Yield** Revise concepts already introduced: - reversible reactions - dynamic nature Graphs representing changes in concentrations of reactants and products as a system reaches equilibrium.	Introduce K_c. Calculations involving K_c fo homogeneous systems.
16	Revise Le Châtelier's Principle introduced earlier. Consider effect of changes in: - concentration - pressure (gaseous systems) - temperature. **Practical:** Effect of changes in concentration on the equilibrium concentration of $Fe(SCN)^{2+}$ in solution.	View film clips of effects of pressure and concentration changes on equilibrium systems. Interpret graphs representing the effect of changes in equilibrium system with concentration, pressure, temperature changes.	**[Subtopic 4.2]** Use of chlorine, hypochlorous acid and hypochlorites in water treatment – effect of pH on the equilibrium. **Revise:** **[Subtopics 1.4, 4.2, 4.3]** Cation exchange Availability of nutrients in soil. Ion chromatography. Use of zeolites in water softeners. **[Subtopic 1.1]** Role of oceans in removing CO_2 from the atmosphere/ocean acidification	**Subtopic 2.3: Optimising Production** Interpret flow charts. Desirable features: high rate, high yield, safe processes, minimum impact on the environment, minimum costs. Discuss compromises to achieve maximum yield in minimum time. Advantages/disadvantages of using catalysts.
17	Examples: Choose from production of ammonia, sulfuric acid, nitric acid	**Subtopic 3.7: Esters** Occurrence Systematic nomenclature Formation from appropriate alcohol and acid – Condensation	Formation of polyesters Hydrolysis of esters under acidic and alkaline conditions.	**Subtopic 3.9: Triglycerides** Formation from 1,2,3-propanetriol and fatty acid. Saturated/unsaturated triglycerides: - sources physical state.

18	**Practical:** Preparation of an ester ⟷		**Practical:** Use bromine solution to test various triglycerides for saturation. Conversion of liquid triglycerides into triglycerides with higher melting point. Discuss production of margarine.	Alkaline hydrolysis of triglycerides. Formation of amphiphilic particles. Explain uses of amphiphilic particles: - to remove grease (soaps and detergents – include effect of hard water) - to stabilise mayonnaise and ice cream - in Nano sized micelles to deliver hydrophobic drugs.
19	**Subtopic 3.8: Amides** Formation by condensation of amine and carboxylic acid. Formation and properties of polyamides. Consider nylon.	Hydrolysis of amides under acidic and alkaline conditions.	**Subtopic 3.10: Proteins** Amino acids - general formula - acidic and basic properties - self-ionised form	Condensation to form protein chain. Protein chains and secondary interactions: - within the chain - between the chain and water.
20	Effect of changes in pH and temperature on the spatial arrangement of the protein chain and hence of its function. Role of enzymes in life processes.	**Subtopic 4.1** Revise material introduced earlier in the year: - fuels - carbon cycle and reactions - fossil and renewable fuels.	Biofuels: - production of ethanol (revise) and biodiesel - biofuels/fossil fuels and global warming	Advantages/disadvantages of using carbon-based fuels for energy. Revise: - combustion (complete/incomplete) - calorimetry/enthalpy of combustion - thermochemical calculations
21	**Practical:** Prepare a sample of biodiesel ⟷		**SAT 3: Test**	Writing thermochemical equations. Compare fuels (including calculations of energies released per mole, per gram, per litre).

22	Revise galvanic cells from Stage 1. Photovoltaic cells. Advantages/disadvantages of direct energy generation.	Fuel cells - structure - half-equations for various fuels - advantages/disadvantages compared with other galvanic cells.	**Subtopic 4.2** Different methods for treating water. Use of aluminium ions and polymers to remove suspended clay particles from water.	Revise: - hard water - use of zeolites in water softeners - use of chlorine and some compounds for disinfection. Reverse osmosis process. Desalination by reverse osmosis and thermal distillation.
23	Discuss issues associated with use of Adelaide desalination plant. **Introduce Investigation (3) SHE: Industrial wastewater**.	Class time for initial research and discussion with teacher ⟷	**Subtopic 4.3: Soil** Why plants need nutrients in soluble form. Revise: - natural and anthropogenic nitrogen-fixing processes Why fertilisers may be needed to improve the productivity of some soils.	Process and consequences of eutrophication
24	Silicon dioxide, silicates and aluminosilicates Formula of anion from formula of silicate of aluminosilicate.	Revise: - cation exchange - impact of acidic and saline conditions on the nutrient value of soils.	**Subtopic 4.4** Revise work on addition polymers from Stage 1, and on condensation polymers from Topic 3.7, 3.8. View VEA Addition Polymers	View VEA Condensation Polymers Advantages/disadvantages of: - synthetic polymers - producing polymers from fossil source or from renewable materials.
25	Properties of organic polymers: - revise secondary interactions from Stage 1 - effect of cross-linking and secondary interactions on rigidity, strength, elasticity, behaviour on heating.	Thermoplastic and thermoset polymers: - structure - effect of heat - impact on ability to be recycled. Impact of disposal of plastics on the environment. Biodegradability	Occurrence of metals – depends on metal reactivity. Stages in the production of metals form their ores – energy requirements. Method of reduction is related to the reactivity of the metal and availability of energy. Depending on metal reactivity may use: - electrolysis of molten salt - electrolysis of aqueous solution - heat and a reducing agent.	Revise electrolysis from Stage 1. Compare reduction methods for the production of: - Group 1 and 2 metals, and aluminium - zinc - iron or copper.

26	Compare environmental impacts of producing aluminium from bauxite with zinc from zinc ore. Discuss phytomining and bioleaching.	Consider production of Zn to revise: - amphiphilic particles (froth flotation) - reactions of metallic oxides with acids - displacement of a metal from solution by a more reactive metal - electrolysis of aqueous solutions.	**Investigation (2): Practical Design** ⟷	
27	Need for the recycling of materials. Discuss energy requirements for recycling aluminium cans and for producing cans from bauxite.	Difficulties in recycling: - thermosetting plastics (revise) - composite materials	**Revision**	**Revision**
28	**Revision**	**Revision**	**SAT 4: Test**	

Stage 2 Chemistry

LAP1 articulates with Program 1

Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio Weighting 30%	**Investigation 1: Volumetric analysis** Students use a range of materials and glassware to perform a volumetric analysis to determine which of three beverages is most acidic. Students demonstrate their ability to: - select glassware appropriate to the task - use volumetric glassware correctly - accurately dilute a solution - perform a titration - calculate [H+] for each beverage and use these to form a conclusion - discuss accuracy and precision of their results - evaluate the procedure and the impact of sources of systematic and random error.	3,4	2,4	This titration is conducted over two lessons. Students work individually and must submit their report in the next lesson following the titration. The report is a maximum of 1000 words, excluding the results section.
	Investigation 2: Design Investigation A. Students design a procedure to investigate the effect of changing one variable on the mass of copper formed during the electrolysis of a copper sulfate solution. They deconstruct the problem to select a variable and an appropriate method for investigation. They may do preliminary work/trials in this lesson, or in their own time leading up to the day of the practical. B. Students construct their own individual design based on their preliminary investigations and carry out this investigation. C. Students write a practical report that demonstrates their ability to: - formulate a hypothesis - identify variables and identify and explain factors that must be held constant - identify factors that they are unable to hold constant - design and conduct an investigation to test the hypothesis - identify safety considerations - record and represent data using appropriate formats - analyse data to formulate a conclusion - evaluate their procedure and the impact, if any, of sources of error on their results - suggest reasonable improvements - communicate material using appropriate language, terminology and conventions.	1,2,3,4	4	Part A (1 lesson) and Part B (2 lessons) are carried out in class time. Students may work in pairs for Part A but work individually in Parts B and C. Individual reports are submitted two school days after completion of the investigation. The report must be a maximum of 1500 words, excluding the materials/apparatus, method/procedure outlining trials, identification and management of safety risks, and results.
	Investigation 3 (SHE): Industrial Wastewater Students choose a context in which water is used and discarded during an industrial process (e.g. agriculture, the wine industry, mining, the desalination process). They investigate the reasons for use of the water, effect on the composition of the water as a result of the use, methods for analysing the concentrations of any contaminants, the possible environmental effects of discarded water, methods of remediation (if any) of the water. In this investigation, students demonstrate their ability to: - locate, select and acknowledge relevant material - apply chemical concepts in new contexts - connect chemical concepts to social, ethical, and environmental impacts - communicate information using appropriate terms, conventions, and representations. Students may choose the format in which to communicate their findings.	3	2,3,4	Students work individually. 1-2 lessons of class time will be available for preliminary research and discussion. They will prepare the report and submit it within four weeks. The communication should be a maximum of 1500 words if written or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.
Assessment Type 2: Skills and Applications Tasks Weighting 40%	**SAT 1: Infographic** This task assesses subtopics 1.1 and 4.1. Students create an infographic that demonstrates knowledge of the chemistry and associated issues involved with increasing carbon emissions.		1, 3, 4	Time: 50 minutes Direct supervision of the teacher. Students are provided with the periodic table and formula sheet.
	SAT 2: Test This test covers parts of Topics 1, 3 and 4. Short answer questions will include: - use of systematic nomenclature of organic compounds - interpretation and use of structural formulae - analysis and interpretation of quantitative data - application of knowledge in familiar and unfamiliar contexts - use of mathematical formulae to solve quantitative problems over a range of complexity.	3	1,2,4	Time: 50 minutes Direct supervision of the teacher. Students are provided with the periodic table and formula sheet.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
	SAT 3: Test This test covers parts of Topics 2, 3 and 4. Short answer questions will include: - relevant calculations - use of systematic nomenclature of organic compounds - interpretation and use of structural formulae - application of knowledge in familiar and unfamiliar contexts - application of chemical concepts in contemporary, social and/or environmental contexts.		1,2,3	Time: 50 minutes Direct supervision of the teacher. Students are provided with the periodic table and formula sheet.
	SAT 4: Test Short answer questions cover Topic 4 and related revision topics (see program) and will include application of chemical concepts in familiar and new contexts and in contemporary, social and/or environmental contexts. It will include one extended response question based upon a short article.	3	1, 2, 4	Time: 90 minutes + 10 minutes reading time. Direct supervision of the teacher. Students are provided with the periodic table, an activity series of metals, and formula sheet.
Assessment Type 3: Examination Weighting 30%	2.5 hour examination	Questions of different types cover all Stage 2 topics and the science inquiry skills. Some questions may require students to integrate their knowledge from more than one topic and show an understanding of science as a human endeavour.		

Eight assessments, including the external examination. *Please refer to the draft Stage 2 Chemistry subject outline.*

AT1 Task 2 Stage 2 Chemistry: Design Investigation – Copper Electroplating

Starter Problem:

During the electroplating process, metal is deposited on the surface of the cathode.

What factors might affect the mass of metal deposited?

In this practical investigation you are required to:

- *deconstruct the parts of a problem to determine the most appropriate method for investigation*
- *formulate a investigable question or hypothesis*
- *select and use appropriate equipment, apparatus, and techniques*
- *identify variables*
- *collect, represent, analyse, and interpret data*
- *evaluate procedures and consider their impact on the results*
- *draw conclusions*
- *communicate knowledge and understanding of concepts.*

It is known that passing a constant electric current through an aqueous copper sulfate solution results in copper atoms from the anode being dissolved into the solution while copper cations from the solution are reduced at the cathode.

<u>At the anode (+)</u> $Cu \longrightarrow Cu^{2+} + 2e^-$

<u>At the cathode (-)</u> $Cu^{2+} + 2e^- \longrightarrow Cu$

Faraday's First Law of electrolysis states that:

"The mass of any element deposited during electrolysis is directly proportional to the number of coulombs of electricity passed"

Faraday's Second Law of electrolysis states that:

"The mass of an element deposited by one Faraday of electricity is equal to the atomic mass in grams of the element divided by the number of electrons required to reduce one ion of the element to its metal."

The copper at the anode releases copper ions and electrons, which move in the solution towards the cathode, where the copper ions and electrons combine to deposit copper onto the cathode.

The expected mass of copper can be calculated by using a series of simple equations:

Charge (C) = Current (A) x Time (s)
Moles of Electrons or Faradays = Charge (C) / 96500
Moles of Copper = Moles of electrons or Faradays / ratio = 2
Mass (g) = moles x relative atomic mass

For example:
If the Current is 0.2A and the time taken is 5 minutes
Charge = 0.2 x (5x60)
Faradays = 60/96500
Moles of Copper = 0.0006217/2
Mass = 0.0003108 x 64
Mass = 0.0199 g

From these equations a "theoretical" table of values can be produced and these can be plotted against the actual results obtained.

Part A: (in pairs) IAE1

Deconstruct the parts of a problem to determine the most appropriate method for investigation

In this investigation, the mass of copper (Cu) metal deposited will be recorded during the electrolysis of copper sulfate solution ($CuSO_4$), as one variable is changed.

Brainstorm factors that could affect the deposition of copper metal on the cathode.

_____ _____
_____ _____
_____ _____
_____ _____

Use the laboratory time to conduct a series of trials to test a particular variable and procedure. Record your observations and consider the strengths and weaknesses of the procedure.

Investigation Design (individually)

- Select one variable to investigate and write an appropriate hypothesis.
- List the independent and dependent variables, factors to be held constant and factors that may not be able to be controlled.
- List the materials required and a detailed procedure.
- Use the results of your trials to justify the details of your procedure.
- Identify ethical and safety considerations.*

Submit your design for teacher feedback.

Part B: Conduct the investigation **(individually)** IAE2
Use the laboratory time to conduct your investigation and record your results.

Part C: Report **(individually)** *(due 2 days after the investigation)* IAE2, IAE3, IAE4, KA4

The practical report should include:

introduction with relevant chemistry concepts, hypothesis and variables

*materials/apparatus**

*method/procedure that outlines the trials and steps to be taken**

*identification and management of safety and/or ethical risks**

*results**

analysis of results, identifying trends, and linking results to concepts

evaluation of procedures and data, and identifying sources of uncertainty

conclusion, with justification.

The report should be a maximum of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

*The four asterisked sections (materials/apparatus, method/procedure, risks, and results) are excluded from the word count.

Performance Standards for Stage 2 Chemistry

		A	B	C	D	E
Investigation, Analysis and Evaluation	**1**	Designs a logical, coherent, and detailed chemistry investigation.	Designs a well-considered and clear chemistry investigation.	Designs a considered and generally clear chemistry investigation.	Prepares the outline of a chemistry investigation.	Identifies a simple procedure for a chemistry investigation.
	2	Obtains records, and represents data using appropriate conventions and formats accurately and highly effectively.	Obtains, records, and represents data using appropriate conventions and formats mostly accurately and effectively.	Obtains, records, and represents data using generally appropriate conventions and formats with some errors but generally accurately and effectively.	Obtains, records, and represents data using conventions and formats inconsistently, with occasional accuracy and effectiveness.	Attempts to record and represent some data with limited accuracy or effectiveness.
	3	Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification.	Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification.	Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification.	Describes data and undertakes some basic interpretation to formulate a basic conclusion.	Attempts to describe results and/or interpret data to formulate a basic conclusion.
	4	Critically and logically evaluates procedures and their effects on data.	Logically evaluates procedures and their effects on data.	Evaluates procedures and some of their effects on data.	Attempts to evaluate procedures or suggest an effect on data.	Acknowledges that procedures affect data.
Knowledge and Application	**1**	Demonstrates deep and broad knowledge and understanding of a range of chemical concepts.	Demonstrates some depth and breadth of knowledge and understanding of a range of chemical concepts.	Demonstrates knowledge and understanding of a general range of chemical concepts.	Demonstrates some basic knowledge and partial understanding of chemical concepts.	Demonstrates some limited recognition and awareness of chemical concepts.
	2	Applies chemical concepts highly effectively in new and familiar contexts.	Applies chemical concepts mostly effectively in new and familiar contexts.	Applies chemical concepts generally effectively in new or familiar contexts.	Applies some chemical concepts in familiar contexts.	Attempts to apply chemical concepts in familiar contexts.
	3	Critically explores and understands in depth the interaction between science and society.	Logically explores and understands in some depth the interaction between science and society.	Explores and understands aspects of the interaction between science and society.	Partially explores and recognises aspects of the interaction between science and society.	Attempts to explore and identify an aspect of the interaction between science and society.
	4	Communicates knowledge and understanding of chemistry coherently with highly effective use of appropriate terms, conventions and representations.	Communicates knowledge and understanding of chemistry mostly coherently with effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of chemistry generally effectively using some appropriate terms, conventions, and representations.	Communicates basic chemical information, using some appropriate terms, conventions, and/or representations.	Attempts to communicate information about chemistry.

AT1 Task 3

Science as a Human Endeavour Investigation – Industrial Wastewater

This task has a focus on science as a human endeavour; how science interacts with society.

Select and explore a recent discovery, innovation, issue, or advancement linked to an industrial process in which water is used and then discarded. Examples could come from agriculture, the wine industry, mining, desalination or other industries.

Use one or more of the key concepts of science as a human endeavour to develop a focus question for your investigation. Make your question quite specific to enable you to analyse information in depth. For example:

How will the wastewater from South Australia's desalination plant affect stenohaline and euryhaline organisms in Spencer Gulf?

Has the development of (a new type of monitoring equipment) helped winery X to improve the quality of the surrounding environment that receives its wastewater after caustic cleaning of equipment?

Is the (new recycling process) for wastewater in the (agricultural industry) safe for (animals or crop irrigation)?

Select, analyse and synthesise information from different sources to:

- explain the science relevant to the focus of your investigation
- show its connections to science as a human endeavour
- develop and justify your own conclusions.

Prepare a scientific report, which must include the use of scientific terminology and:

- an introduction to identify the focus of the investigation and the key concept(s) of science as a human endeavour that it links to
- an explanation of how the focus of the investigation illustrates the interaction between science and society
- relevant chemistry concepts or background
- a discussion of the potential impact or application of the focus of the investigation, e.g. further development, effect on quality of life, environmental implications, economic impact, intrinsic interest
- a conclusion with justification
- citations and referencing.

The report, which can be in a format of your choice, should be a maximum of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

Performance Standards for Stage 2 Chemistry

		A	B	C	D	E
Investigation, Analysis and Evaluation	1	Designs a logical, coherent, and detailed chemistry investigation.	Designs a well-considered and clear chemistry investigation.	Designs a considered and generally clear chemistry investigation.	Prepares the outline of a chemistry investigation.	Identifies a simple procedure for a chemistry investigation.
	2	Obtains records, and represents data using appropriate conventions and formats accurately and highly effectively.	Obtains records, and represents data using appropriate conventions and formats mostly accurately and effectively.	Obtains, records, and represents data using generally appropriate conventions and formats with some errors but generally accurately and effectively.	Obtains, records, and represents data using conventions and formats inconsistently, with occasional accuracy and effectiveness.	Attempts to record and represent some data with limited accuracy or effectiveness.
	3	Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification.	Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification.	Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification.	Describes data and undertakes some basic interpretation to formulate a basic conclusion.	Attempts to describe results and/or interpret data to formulate a basic conclusion.
	4	Critically and logically evaluates procedures and their effects on data.	Logically evaluates procedures and their effects on data.	Evaluates procedures and some of their effects on data.	Attempts to evaluate procedures or suggest an effect on data.	Acknowledges that procedures affect data.
Knowledge and Application	1	Demonstrates deep and broad knowledge and understanding of a range of chemical concepts.	Demonstrates some depth and breadth of knowledge and understanding of a range of chemical concepts.	Demonstrates knowledge and understanding of a general range of chemical concepts.	Demonstrates some basic knowledge and partial understanding of chemical concepts.	Demonstrates some limited recognition and awareness of chemical concepts.
	2	Applies chemical concepts highly effectively in new and familiar contexts.	Applies chemical concepts mostly effectively in new and familiar contexts.	Applies chemical concepts generally effectively in new or familiar contexts.	Applies some chemical concepts in familiar contexts.	Attempts to apply chemical concepts in familiar contexts.
	3	Critically explores and understands in depth the interaction between science and society.	Logically explores and understands in some depth the interaction between science and society.	Explores and understands aspects of the interaction between science and society.	Partially explores and recognises aspects of the interaction between science and society.	Attempts to explore and identify an aspect of the interaction between science and society.
	4	Communicates knowledge and understanding of chemistry coherently with highly effective use of appropriate terms, conventions and representations.	Communicates knowledge and understanding of chemistry mostly coherently with effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of chemistry generally effectively using some appropriate terms, conventions, and representations.	Communicates basic chemical information, using some appropriate terms, conventions, and/or representations.	Attempts to communicate information about chemistry.

Stage 2 Chemistry SAT task

Your task is to create an infographic that will demonstrate your knowledge of the chemistry and associated issues involved with increased carbon emissions.

The science understanding that must be evident in your work comes from subtopics 1.1 and 4.1.

Your finished work should link the following concepts to carbon emissions:

- greenhouse effect
- climate change
- ocean acidification
- photosynthesis
- combustion of fuels
- renewable and non-renewable energy sources

There should also be:

- an explanation of how fossil fuels contribute more than biofuels to global warming
- an explanation of an example of how a new technology has improved the efficiency of a process that emits or captures CO_2 and how this benefits the environment.

You can use the infographic at http://www.compoundchem.com/wp-content/uploads/2017/01/Carbon-Dioxide-and-Ocean-Acidification.png

as an example of how to layout your work. Make sure that you present information at a Stage 2 Chemistry level by addressing the required specific features. You will need to acknowledge your sources of information appropriately.

Assessment Conditions

You will have 1 – 2 weeks of your own time to complete this task. A draft of the material you will present is due after 1 week.

Draft due date: _____

Present your infographic as an A3 size poster.

Due date: _____

The specific features assessed are:

KA1 Demonstration of knowledge and understanding of chemical concepts.

KA3 Exploration and understanding of the interaction between science and society.

KA4 Communication of knowledge and understanding of chemical concepts and information, using appropriate terms, conventions, and representations.

Knowledge and Application	
A	Demonstrates deep and broad knowledge and understanding of a range of chemical concepts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of chemistry coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Demonstrates some depth and breadth of knowledge and understanding of a range of chemical concepts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of chemistry mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Demonstrates knowledge and understanding of a general range of chemical concepts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of chemistry generally effectively, using some appropriate terms, conventions, and representations.
D	Demonstrates some basic knowledge and partial understanding of chemical concepts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic chemical information, using some appropriate terms, conventions, and/or representations.
E	Demonstrates limited recognition and awareness of chemical concepts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about chemistry.

Stage 2 Chemistry: Program 2: 20 credits

This teaching program articulates with learning and assessment plan 2.

Week	Science Understandings	SIS	SHE	Summative Assessment
Term 1 Week 1	Introduction to Stage 2 Topic 1: Monitoring the Environment • Greenhouse Gases • climate change • Oceans and CO_2 • Equations-acids and carbonates	• Practical: Carbonates and Acids	• Watch sections of An Inconvenient Truth • Discuss the impact of the thawing of Permafrost • Kyoto	
Week 2	• Calculations for pH • Nitrogen Oxides and equation • Ozone • Nitrogen Oxides and cars		• Importance of ozone for absorbing UV radiation.	
Week 3-4	• Units for concentration, interconvert • Stoichiometric calculations	• Practical: Titrations		
Week 5-6	• Chromatography • Calculations • Intro to Ion exchange chromatography	• Practical: Investigate caffeine in energy drinks using TLC • Separate chlorophyll from spinach leaves-column chromatography		**Practical Investigation:** Compare effectiveness of 2 antacids
Week 7	• Atomic Spectroscopy • Use in quantitative analysis	• Video	• Applications of AAS	
Week 8	Topic 2: Managing Chemical Processes • Rates of reactions (include enzymes) • Collision Theory • Energy profile diagrams	• Practical: Investigate the rate of reactions		**Test: Topic 1**: Monitoring the Environment

Weeks 9-11	• Equilibrium • LeChatelier's principle • Industrial Processes	• Practical: effects of change in concentration on the equilibrium concentration of $Fe(SCN)^{2+}$	• Impact of Fertilisers (Haber Process)	
Term 2 Week 1	Topic 3: Organic and Biological Chemistry • Molecular formula of organic compounds (extended, condensed or skeletal formula)	• Practise naming and drawing organic molecules	• Effect of advertising that uses scientific information, e.g. Hylamide, on purchase of beauty products	**Test: Topic 2:** Managing Chemical Processes
Week 2	• Review secondary interactions • Physical properties of organic compounds	• Simple experiments to observe the physical properties in organic compounds		
Week 3	• Alcohols	• Practical: Test a range of alcohols with acidified $K_2Cr_2O_7$		
Week 4	• Aldehydes and Ketones	• Practical: prepare an aldehyde		
5	• Carbohydrates • Disaccharides and Polysaccharides			
6	• Carboxylic Acids • Equations • Solubility	• Practical: Titration (review from Topic 1)	• Organic compounds in drugs	
7	• Amines • Structure (primary, secondary, tertiary)			
8	• Esters • Condensation reactions • Reflux • Hydrolysis	• Practical: prepare and ester (could also hydrolyse)		

9.	• Amides • Edible fats and oils • Triglycerides- saturated and unsaturated	• Practical: Bromine solution and saturated/unsaturated triglycerides		
10	• Proteins • Amino acids • Peptide links • Structure of proteins-secondary interactions • Biological functions			**Test: Topic 3:** Organic and Biological Chemistry
Term 3 Week 1	Topic 4: Managing Resources • Carbon based fuels • Photosynthesis • Respiration • Combustion • Fossil Fuels			
2	• Renewable Energy • Fossil Fuels • Bio Fuels • Effect on environment		• Microbes and bio-fuels- innovative technologies	**SHE TASK:** Topic selection.
3	• Bio-fuel production • Renewable energy sources and global warming	• Practical: Fermentation or produce bio-diesel	• Advantages and disadvantages of adding ethanol to petrol	SHE TASK: Class time and verification
4	• Carbon based fuels and energy • Feedstock • Equations			SHE Investigation Due
5	• Incomplete combustion • Energy released in combustion can be experimentally measured	• Calorimetry		**Design Practical Investigation:** Charcoal fuels

6	• Energy Output of Fuels • Photovoltaic and Fuel Cells vs Steam Turbines • Flow cells		• Photovoltaic cells- clean energy	
7	• Water Treatment			
8	• Soil Chemistry • Plant nutrients and soil nutrient levels • Nitrogen, phosphorus, potassium • Fertilisers			
9	• Materials-polymers • Synthetic polymers • Organic polymers • Metal extraction	• Practical: electrolysis- using copper electrodes to extract metals from solution		
10	• Recycling • Review		• Discuss the energy cost to recycle aluminium cans	**Test: Topic 4:** Managing Resources

Stage 2 Chemistry

Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio Weighting 30%	**Investigation 1: Effectiveness of antacid preparations** Students undertake a practical investigation to compare the effectiveness of two antacid preparations. A known amount of antacid is dissolved in an excess of HCl, and then the excess acid is back-titrated with standardised NaOH solution. Students the experiment in groups but individually record and present data using appropriate terms and conventions in a report. Students evaluate procedures and discuss their effects on the data collected. They use their findings to discuss the advantages and disadvantages of using these fuels in different applications.	2, 3	2	Each student submits a practical report according to the guidelines in the subject outline. Word Count: maximum of 1500 words or 10 minutes for an oral presentation for the introduction, analysis, evaluation and conclusion sections of the report.
	Investigation 2: Design Investigation Students deconstruct the problem "What's the best charcoal fuel to use in a home barbeque?" and investigate how one factor affects the heat generated by various charcoal fuels. They work in pairs to trial a procedure to compare the heat generated by different charcoal fuels and then individually design an investigation with an appropriate hypothesis, variables and method. Each student submits a practical report according to the guidelines in the subject outline.	1 ,2 ,3, 4	4	Class time is given for students to design and trial the investigation. Students may submit one draft for feedback Students undertake the practical in pairs. Word Count: maximum of 1500 words or 10 minutes for an oral presentation for the introduction, analysis, evaluation and conclusion sections of the report.
	Investigation 3 (SHE): Global Warming The Science as a Human Endeavour Investigation enables students to demonstrate a comprehensive understanding of an aspect of, or context related to global warming. Students will select at least one aspect of the Science as a Human Endeavour understandings as a basis for their investigation. Students use relevant chemical concepts and information from different sources to explain the significance of the focus of the investigation. Students choose the format for their investigation: either an article for a scientific journal, a written report providing an expert's point of view, or an analysis of a new development that has economic, social, environmental or political implications and acknowledge appropriate sources.	3	2, 3, 4	2 weeks to complete. Class time provided for research and to support students. Students submit a focus and plan for review by the teacher. Verification of work occurs as the student undertakes research and planning. Students may submit one draft for feedback Word Count: maximum of 1500 words or 10 minutes for an oral presentation.
Assessment Type 2: Skills and Applications Tasks Weighting 40%	**Topic 1: Monitoring the Environment**. The content of the task covers key concepts from any aspect of the topic taught. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They solve problems, and interpret data or diagrams. Questions include those in which students use science inquiry skills to provide an answer. An extended response question is included. A number of questions address aspects of Science as a Human Endeavor. Correct use of chemical terminology, formulae and equations is assessed.	2, 4	1, 3, 4	Supervised written assessment. Total Time: 55 minutes + 5 minutes reading time. Students are provided with a sheet containing a Periodic Table and standard SI prefixes.
	Topic 2: Managing Chemical Processes. The content of the task covers key concepts from any aspect of the topic taught. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They solve problems, and interpret data or diagrams. Questions include those in which students use science inquiry skills to provide an answer. Correct use of chemical terminology, formulae and equations is assessed.	1, 3	1,2,4	Supervised written assessment. Total Time: 90 minutes + 5 minutes reading time. Students are provided with a sheet containing a Periodic Table and standard SI prefixes.
	Topic 3: Organic and Biological Chemistry. The content of the task covers key concepts from any aspect of the topic taught. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They solve problems, and interpret data or diagrams. Questions include those in which students use science inquiry skills to provide an answer. An extended response question is included. Correct use of chemical terminology, formulae and equations is assessed.	2	1, 2, 4	Supervised written assessment. Total Time: 90 minutes + 5 minutes reading time. Students are provided with a sheet containing a Periodic Table and standard SI prefixes.
	Topic 4: Managing Resources. The content of the task covers key concepts from any aspect of the topic taught. Students apply their knowledge and skills to a range of questions in both new and familiar contexts. They solve problems, and interpret data or diagrams. Questions include those in which students use science inquiry skills to provide an answer. An extended response question is included. A number of questions address aspects of Science as a Human Endeavor. Correct use of chemical terminology, formulae and equations is assessed.	3	1, 3, 4	Supervised written assessment. Total Time: 90 minutes + 5 minutes reading time. Students are provided with a sheet containing a Periodic Table, standard SI prefixes, and table showing relative activities of a number of metals.
Assessment Type 3: Examination Weighting 30%	2.5 hour examination.	Questions of different types cover all Stage 2 topics and the science inquiry skills. Some questions may require students to integrate their knowledge from more than one topic and show an understanding of science as a human endeavour.		

Eight assessments. *Please refer to the Stage 2 Chemistry subject outline.*

Stage 2 Chemistry: Design Practical Investigation

In this task you will investigate how one factor affects the heat generated by various charcoal fuels to help answer the following question:

> Charcoal for barbeques is sold mainly as either lump charcoal or as moulded briquettes. There are many different brands available to the consumer. What's the best charcoal fuel to use in a home barbeque?

- *Step 1 (in pairs)* IAE1

  Research the types of charcoal available by visiting the supermarket or using information from the Internet. List the various factors that differ between these types that might influence the amount of heat generated in a barbeque.

- *Step 2 (in pairs) IAE1*

  Select one factor to investigate and design a laboratory procedure to compare the heat generated by fuels in which this factor varies.
  Identify:
  - the independent and dependent variables
  - the hypothesis
  - a procedure to trial

  Carry out a trial. Record your observations and notes about the procedure and modifications you might make for your actual investigation.

- *Step 3 (individually) IAE1*

  Design your own investigation.
  - List the independent and dependent variables, factors to be held constant and factors that may not be able to be controlled.
  - List the materials required and a detailed procedure.
  - Use the results of your trial to justify the details of your procedure.
  - Identify ethical and safety considerations.*

  Submit your design for teacher feedback.

- *Step 4 (in pairs) IAE2*

  Select, and carry out, one investigation and record your observations.

- *Step 5 (individually) IAE3, IAE4, KA4*

  Write your report, which should include:
  - introduction with relevant chemistry concepts, hypothesis and variables
  - materials/apparatus*
  - method/procedure that outlines the trials and steps to be taken*
  - identification and management of safety and/or ethical risks*
  - results*
  - analysis of results, identifying trends, and linking results to concepts
  - evaluation of procedures and data, and identifying sources of uncertainty
  - conclusion, with justification.

  The report should be a maximum of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

  *The four asterisked sections (materials/apparatus, method/procedure, risks, and results) are excluded from the word count.

Performance Standards for Stage 2 Chemistry

		A	B	C	D	E
Investigation, Analysis and Evaluation	**1**	Designs a logical, coherent, and detailed chemistry investigation.	Designs a well-considered and clear chemistry investigation.	Designs a considered and generally clear chemistry investigation.	Prepares the outline of a chemistry investigation.	Identifies a simple procedure for a chemistry investigation.
	2	Obtains records, and represents data using appropriate conventions and formats accurately and highly effectively.	Obtains, records, and represents data using appropriate conventions and formats mostly accurately and effectively.	Obtains, records, and represents data using generally appropriate conventions and formats with some errors but generally accurately and effectively.	Obtains, records, and represents data using conventions and formats inconsistently, with occasional accuracy and effectiveness.	Attempts to record and represent some data with limited accuracy or effectiveness.
	3	Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification.	Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification.	Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification.	Describes data and undertakes some basic interpretation to formulate a basic conclusion.	Attempts to describe results and/or interpret data to formulate a basic conclusion.
	4	Critically and logically evaluates procedures and their effects on data.	Logically evaluates procedures and their effects on data.	Evaluates procedures and some of their effects on data.	Attempts to evaluate procedures or suggest an effect on data.	Acknowledges that procedures affect data.
Knowledge and Application	**1**	Demonstrates deep and broad knowledge and understanding of a range of chemical concepts.	Demonstrates some depth and breadth of knowledge and understanding of a range of chemical concepts.	Demonstrates knowledge and understanding of a general range of chemical concepts.	Demonstrates some basic knowledge and partial understanding of chemical concepts.	Demonstrates some limited recognition and awareness of chemical concepts.
	2	Applies chemical concepts highly effectively in new and familiar contexts.	Applies chemical concepts mostly effectively in new and familiar contexts.	Applies chemical concepts generally effectively in new or familiar contexts.	Applies some chemical concepts in familiar contexts.	Attempts to apply chemical concepts in familiar contexts.
	3	Critically explores and understands in depth the interaction between science and society.	Logically explores and understands in some depth the interaction between science and society.	Explores and understands aspects of the interaction between science and society.	Partially explores and recognises aspects of the interaction between science and society.	Attempts to explore and identify an aspect of the interaction between science and society.
	4	Communicates knowledge and understanding of chemistry coherently with highly effective use of appropriate terms, conventions and representations.	Communicates knowledge and understanding of chemistry mostly coherently with effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of chemistry generally effectively using some appropriate terms, conventions, and representations.	Communicates basic chemical information, using some appropriate terms, conventions, and/or representations.	Attempts to communicate information about chemistry.

Science as a Human Endeavour Investigation – Global Warming

This task has a focus on science as a human endeavour; how science interacts with society.

Select and explore a recent discovery, innovation, issue, or advancement linked to the effects of or the reduction of CO_2 emissions to the atmosphere. Examples include clean coal technology, carbon capture and storage, photovoltaic cell research, changes in marine mollusc shell properties, and the destruction of the Great Barrier Reef.

Use one or more of the key concepts of science as a human endeavour to develop a focus for your investigation. Make your topic quite specific to enable you to analyse information in depth. For example:

How new carbon capture and storage technologies provide sustainable solutions for reducing global warming

The impact of increasing the proportion of wind energy sources for South Australia's electricity supply

The role of sceptics in hindering the reduction of CO_2 emissions to the atmosphere

Select, analyse and synthesise information from different sources to:

- explain the science relevant to the focus of your investigation
- show its connections to science as a human endeavour
- develop and justify your own conclusions.

Prepare a scientific report, which must include the use of scientific terminology and:

an introduction to identify the focus of the investigation and the key concept(s) of science as a human endeavour that it links to

an explanation of how the focus of the investigation illustrates the interaction between science and society

relevant chemistry concepts or background

a discussion of the potential impact or application of the focus of the investigation, e.g. further development, effect on quality of life, environmental implications, economic impact, intrinsic interest

a conclusion with justification

citations and referencing.

The report, which can be in a format of your choice, should be a maximum of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

Performance Standards for Stage 2 Chemistry

		A	B	C	D	E
Investigation, Analysis and Evaluation	1	Designs a logical, coherent, and detailed chemistry investigation.	Designs a well-considered and clear chemistry investigation.	Designs a considered and generally clear chemistry investigation.	Prepares the outline of a chemistry investigation.	Identifies a simple procedure for a chemistry investigation.
	2	Obtains records, and represents data using appropriate conventions and formats accurately and highly effectively.	Obtains, records, and represents data using appropriate conventions and formats mostly accurately and effectively.	Obtains, records, and represents data using generally appropriate conventions and formats with some errors but generally accurately and effectively.	Obtains, records, and represents data using conventions and formats inconsistently, with occasional accuracy and effectiveness.	Attempts to record and represent some data with limited accuracy or effectiveness.
	3	Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification.	Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification.	Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification.	Describes data and undertakes some basic interpretation to formulate a basic conclusion.	Attempts to describe results and/or interpret data to formulate a basic conclusion.
	4	Critically and logically evaluates procedures and their effects on data.	Logically evaluates procedures and their effects on data.	Evaluates procedures and some of their effects on data.	Attempts to evaluate procedures or suggest an effect on data.	Acknowledges that procedures affect data.
Knowledge and Application	1	Demonstrates deep and broad knowledge and understanding of a range of chemical concepts.	Demonstrates some depth and breadth of knowledge and understanding of a range of chemical concepts.	Demonstrates knowledge and understanding of a general range of chemical concepts.	Demonstrates some basic knowledge and partial understanding of chemical concepts.	Demonstrates some limited recognition and awareness of chemical concepts.
	2	Applies chemical concepts highly effectively in new and familiar contexts.	Applies chemical concepts mostly effectively in new and familiar contexts.	Applies chemical concepts generally effectively in new or familiar contexts.	Applies some chemical concepts in familiar contexts.	Attempts to apply chemical concepts in familiar contexts.
	3	Critically explores and understands in depth the interaction between science and society.	Logically explores and understands in some depth the interaction between science and society.	Explores and understands aspects of the interaction between science and society.	Partially explores and recognises aspects of the interaction between science and society.	Attempts to explore and identify an aspect of the interaction between science and society.
	4	Communicates knowledge and understanding of chemistry coherently with highly effective use of appropriate terms, conventions and representations.	Communicates knowledge and understanding of chemistry mostly coherently with effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of chemistry generally effectively using some appropriate terms, conventions, and representations.	Communicates basic chemical information, using some appropriate terms, conventions, and/or representations.	Attempts to communicate information about chemistry.

Stage 2 Earth and Environmental Science: Program 1: 20 credits

This teaching program articulates with learning and assessment plan 1.

Week	Science Understandings	SIS	SHE	Assessment Tasks
Term 1 Week 1-2	Introduction to Stage 2 Topic 1: Introduction to Earth Systems • Components and process of the systems: Hydrosphere, atmosphere, biosphere and geosphere • Interactions between the systems – carbon, nitrogen, phosphorus and hydrological cycles	• Practical Investigation: interaction of Earth Systems in the local area	• SHE Investigation: Case study – Cleaning up an oil spill	
Week 3	• Identifying and measuring change in in systems • Patterns and changes over a variety of time scales • Predicting future changes	• Introduction to field skills – sampling techniques, testing equipment, recording devices		
Week 4	• Inquiry into Earth systems	• Field Investigation: local area Earth Systems Inquiry		
Week 5-6	Topic 2: Earth's Resources • Use of geological resources • Renewable and non-renewable resources • Formation of, exploration for and sustainability of energy resources		• SHE investigation: Issues associated with the extraction of unconventional gas	**SAT: Earth Systems poster**
Week 7- 8	• Formation of metallic resources • Exploration for metallic resources • Extraction and refining of metallic resources • Sustainability of metallic resources	• Practical investigation: identification of metallic minerals and host rocks • Practical Investigation: Exploration techniques - What's inside the Black Box? • Practical Investigation: Magnetic surveying	• SHE Investigation: Recycle, reuse, reduce	
Week 9- 11	• Environmental impacts of the extraction and use of mineral and energy resources		• SHE Investigation: Case study of impacts of mining on ecosystems	**Field Investigation**: Effects of sulfide mining on an ecosystem - Brukunga

Week	Science Understandings	SIS	SHE	Assessment Tasks
Term 2 Week 1	Topic 3 Earth's Sustainable Future • Renewable sources of energy resources	• Practical Investigation – generating solar and wind power	• Tour of the Adelaide Showgrounds solar project	**Topic test** – Earth Resources
Week 2	• Soil formation and structure • Sustainability of soil and water	• Practical investigation – soil composition and structure		Field Investigation due
Week 3- 5	• Availability and quality of fresh water • Recycling of stormwater and effluent water	• Field Investigation – wetlands (Urrbrae, Salisbury)	• SHE Investigation: causes and remediation of algal blooms, sewerage, industrial waster	
Week 6- 7	• Pollution of groundwater and waterways	• Field Investigation – local catchment area and creek study • Use a sand tank to investigate groundwater systems		**Design Practical Investigation**: Exploring Groundwater systems with sand tank model
Week 8	• Effective use of energy resources	• Investigation – estimate individual carbon footprint	• SHE investigation – identify ways to reduce our carbon footprint	
Week 9	• Advantages and disadvantages of using renewable and non-renewable energy resources		• SHE investigation – impacts of introducing renewable energy to local ecosystems	
Week 10	Topic 4 Climate Change • Evolution of the Earth's atmosphere • Greenhouse effect and greenhouse gases	• Practical Investigation: modelling the evolution of the Earth's atmosphere		
Term 3 Week 1	• Astronomical cycles and sunspot activity • Influence of plate tectonics	• Investigation: the 'Little Ice age'		**Topic test**: Earth's Sustainable Future
Week 2	• Oceans absorb large amounts of solar radiation • Ocean circulation • Shallow and deep water ocean currents • Thermohaline circulation			
Week 3	• Anthropogenic activities affect climate • Enhanced greenhouse effect	• Investigation: No Zone of Ozone		

Week	Science Understandings	SIS	SHE	Assessment Tasks
Week 4	• Effects of climate change on Earth Systems	• Investigation: Modelling the Earth's Energy balance	• SHE Investigation: Managing the health effects of climate change (Lancet)	
Week 5	• Evidence for climate change • Climate proxies	• Practical investigation: climatic analysis using foraminifera • Practical investigation: oxygen isotopes – a proxy for sea surface temperatures	• Formative SHE task: Climate Change	
Week 6	• Models for predicting climate change • Local, national and international responses to climate change	• Prepare for Earth Systems Study	• SHE Investigation: Paris and the IPCC	Hypothesis for Earth Systems study due
Week 7		• Design Earth Systems Study		Design and risk assessment for Earth Systems study due
Week 8		• Conduct Earth Systems Study*		
Week 9		• Analyse data and complete report		**External Earth Systems Study** report due
Week 10			• Preparation for SHE investigation	SHE Investigation topic selection
Term 4 Week 1				**SHE Investigation** due
Week 2				**Topic test**: Climate Change

*Earth Systems Study may include a class Field camp

Stage 2 Earth and Environmental Science – Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio Weighting 30%	**Team Field Investigation**: Effects of sulfide mining on an ecosystem – Brukunga Students will work in teams of 4 to identify a problem that sulfide mining has caused in the local ecosystem of the Dawsley Creek catchment area. They collect primary data using a range of field sampling techniques, chemical and physical tests, and field notes. Students individually analyse their data and identify how the mining operation has impacted on interactions within and between Earth systems. Students will submit an individual field report and their field note book.	2,3,4	2,4	Planning and preparation including risk assessment and researching secondary data – 2 lessons. Field sampling and testing – day field trip – 4 – 5 hours Total of 1500 words (excluding plan, materials, risk assessment, results)
	Design Practical Investigation: Exploring Groundwater systems with sand tank model Students use a groundwater mode to individually design an investigation around the impact of groundwater use on groundwater quality and/or quantity. When the design has been assessed, students in pairs, nominate the design to implement. Students make and record observations, analyse their observations, and formulate conclusions. Students prepare and submit an individual report.	1,2,3,4	1,4	Design – individual; Implementation - collaborative, supervised task. Planning and preparation including risk assessment – 1 lesson Modelling and data collection: 120 minutes in the Flinders University School of Earth Sciences laboratory. Total of1500 words (excluding materials, method, results)
	SHE Investigation: Students investigate an aspect of Earth Systems with an emphasis on Science as a Human Endeavour. This investigation focuses on at least one key concept of Science as a Human Endeavour and may draw on a context suggested in the topics being studied or explore a new context.	3	2,3,4	Students have 2 weeks to gather information to use to write the report. The report is an individual task. Up to a maximum of 1500 words or a maximum of 10 minutes in total for an oral presentation, or the equivalent in multimedia form.
Assessment Type 2: Skills and Applications Tasks Weighting 40%	**Earth Systems Poster**: Students work in teams to identify and analyze a problem where human activity has impacted on the interactions within and between Earth Systems. They prepare a presentation using data selected from a range of sources examining the Earth System interactions, the history of the development of the problem, and the implementation of actions to minimise the impacts of the human activity. Students will individually construct a 250 word reflection summarising the feedback from their poster presentation and identify areas for improvement.	2,3	1,3,4	Collaborative oral presentation to support the poster presentation. Students will have 1 lesson of planning time and 1 week to gather information and construct their poster. Students will present their poster to the class, teacher, and a panel of experts in a gallery walk and will have the opportunity to respond to questions from the teacher, students, and experts. Individual 250 word reflection.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
	Topic Test: Earth Resources Students demonstrate knowledge and understanding of Topic 2: Earth Resources. They apply their knowledge, analyse hand specimens and data, and form conclusions using appropriate terms and conventions. They do this in a range of question types: multiple choice, short answer, and extended response.	2, 3	1,2,3,4	90 minute timed test under supervision.
	Topic Test: Earth's Sustainable Future Students demonstrate knowledge and understanding of Topic 3: Earth's Sustainable Future. They apply this knowledge, analyse data, and form conclusions using appropriate terms and conventions. They do this in a range of question types: multiple choice, short answer, and extended response.	3	1,2,3,4	90 minute timed test under supervision.
	Topic Test: Climate Change Students demonstrate knowledge and understanding of Topic 4: Climate Change. They apply this knowledge, analyse data, and form conclusions using appropriate terms and conventions. They do this in a range of question types: multiple choice, short answer, and extended response.	3	1,2,3,4	90 minute timed test under supervision.
Assessment Type 3: Earth Systems Study Weighting 30%	Students undertake one fieldwork investigation into a particular local environmental issue, concern, initiative, or successful undertaking that can be linked to topics studied in Stage 2 Earth and Environmental Science. Students develop a research question, then design, plan, undertake, and report on a field-based extended investigation to answer the question. Students analyse the information gathered in terms of the interactions of two or more Earth system.	1, 2, 3, 4	1, 4	The proposal and report address the requirements in the subject outline and should be a maximum of 2000 words, if written, or the equivalent in multimodal form.

Eight assessments. *Please refer to the Stage 2 Earth and Environmental Science subject outline.*

Stage 2 Earth and Environmental Science: Investigation Folio Task #2

Formative activity
Groundwater Hydrology:
Exploring a groundwater system through a sand-tank model

In this activity, you will use a groundwater model, like the one shown in figure 1 (p. 2), to study the movement of water through an aquifer. The model represents a cross-section of a groundwater system.

Features of the Model

1 Use the signs on the model to label the photograph of figure 1, indicating the groundwater system features.

2 Describe the difference between the situations of the shallow, unconfined, aquifer and the artesian aquifer.

_____

_____

3 Compare the grain sizes of the sediments that make up the shallow, unconfined, aquifer with those of the coarse wedge and the artesian aquifer.

_____

_____

4 In what way does the confining layer differ from the two aquifers?

_____

_____

5 From where is water fed into the system? _____

6 Describe the feature of the model that represents the **intake area** for the groundwater system.

_____

_____

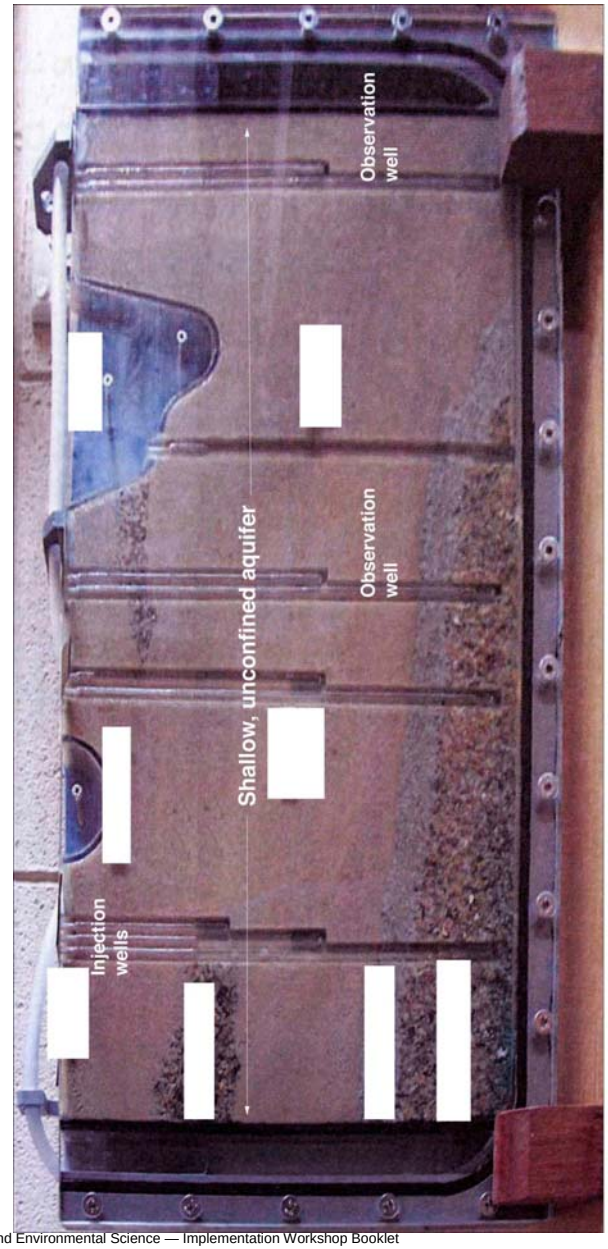


Figure 1 — Groundwater Model

7. Describe the two locations from which water leaves the system.

_____

_____

The Water Table

Turn on the tap so that water flows through the model. Make sure that the water level remains constant, so that the system does not overflow.

N.B. Take great care when handling the long needle. Do not force the tip through the fine mesh at the base of the wells.

1. To locate the **water table** of the groundwater model:

   a. Dip the tip of the long needle into food colouring and then carefully insert it down one of the shallow observation wells, just below the water level.
   The level of the water surface in this well is the water table.

   b. Repeat step 1 a. using the other shallow observation well.

   c. Use a felt pen on the glass front of the model to join the water tables indicated by the two wells. Include the level of the water in the lake, if the lake contains water.

   d. Indicate on figure 2 the approximate position of the water table in the model.

2. Place the small grey nozzle of the pump firmly but gently into the top of one of the shallow observation wells. Squeeze the trigger a few times to begin pumping water from the well.

   a. Describe what happens to the water levels in the adjacent wells and in the lake if it contains water.

   _____

   _____

   b. Indicate these changes on figure 2.

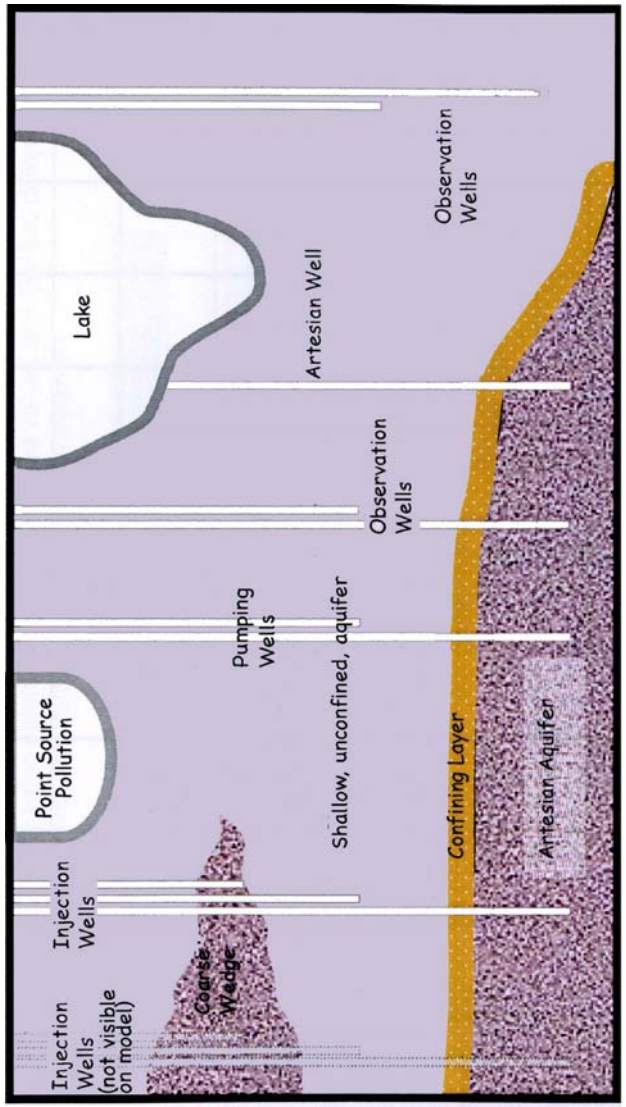


Figure 2 — A Diagram of the Model

The Groundwater Flow Path

1. Attach the long needle to the large syringe and carefully inject a **small amount** of colouring into the injection wells. Observe the movement of coloured water as is travels through the shallow aquifer and the deep aquifer.

   a. Compare the water velocities and flow patterns in the shallow aquifer with those in the deep aquifer.

   _____

   _____

   b. On figure 2, draw and label the paths of the coloured water through the two aquifers.

2. Describe and explain any changes you can see in the lake.

   _____

   _____

   _____

3. a. Explain why the water spreads out to form a plume of colour as it moves across the shallow aquifer.

   _____

   _____

   b. Make sure you show this spreading effect on Figure 2.

Effects of Pumping Water from the Wells

Use the pump to extract more water from one of the shallow observation wells.

1. a. Describe what happens to the level of water around the well you are pumping from.

   _____

   _____

   b. Sketch this effect in figure 2.

2. Describe what happens to the plumes of colour you have been observing.

   _____

3. Discuss the impact of pumping on the groundwater system as a whole, including the artesian aquifer.

   _____

Contamination of a Groundwater System

Attach one of the small grey tips to the smaller syringe, extract some more colour and add a few drops to the point source to represent a contaminated site.

Now squirt some water from the wash bottle provided to represent rain falling on the area.

1.. Describe the effect of rain on the spread of contamination.

_____

_____

2 Pump water from different observation wells and observe changes in the entire groundwater system. Describe these changes.

_____

_____

Groundwater Design Practical Investigation

Purpose

This assessment allows you to develop and demonstrate your practical investigation skills using a groundwater model, like the one shown in figure 1. The model represents a cross-section of a groundwater system.

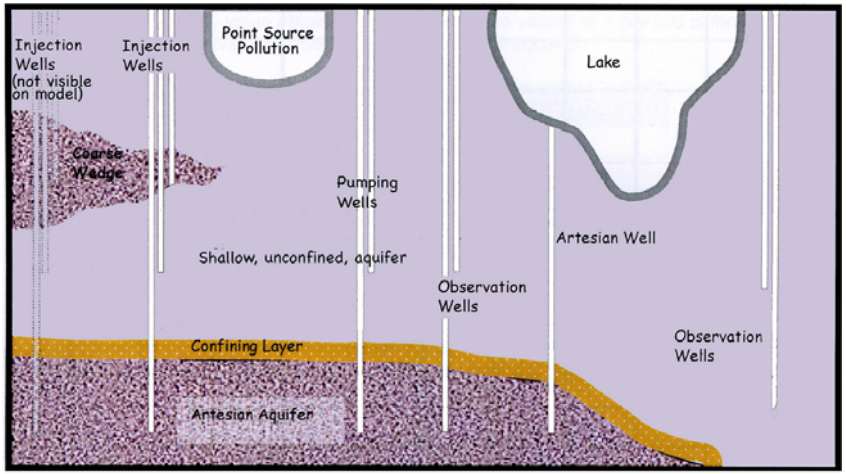


Figure 1 – Illustration of a sand- tank groundwater system model

You will need to complete the formative activity *'Exploring a ground water system through a sand tank model'* to understand the connections between the various elements in the sand-tank model. This will help you to think about the relationships between ground water and surface water systems. You will then identify a problem involving the movement of water through an aquifer and use the model to collect data.

Part A: Design Proposal (design pre- investigation with modifications during investigation).
IAE1

Individually, research the principles of movement of groundwater
You will then be placed in groups of three to formulate possible questions that you can investigate using the sand-tank groundwater model. For example, you could consider the impact of withdrawal rate from the artesian aquifer on water level in the lake.

Proposal Development

Purpose: Deconstructing the parts of a problem to determine the most appropriate method for investigation

- State the specific purpose of your investigation.

Hypothesis: Formulating investigable questions and hypotheses

- State the hypothesis for the investigation

Variables and Constants
Identifying variables

- State the independent variable.
- Describe how the independent variable is to be varied.
- State the dependent variable.
- Describe how the dependent variable will be measured.
- Identify factors that should be kept constant and describe how, or whether, they will be kept constant.

Materials and Equipment:
Selecting and using appropriate equipment, apparatus, and techniques

- List all chemicals and equipment, including the quantities, required

Method:
Selecting and using appropriate equipment, apparatus, and techniques

- Describe your procedure, using clear and detailed steps that others can follow.
- Consider the number of samples to test and the need for repetition.
- Complete a risk assessment and determine equipment requirements.
- Describe potential safety issues and how you will minimise them.
- Describe any ethical issues and how you will minimise them.

Due date for design proposal:

Part B: Conducting the investigation (collaborative) IAE1
Trial the method you have proposed and modify to suit the conditions.
Conduct your investigation recording raw data in a suitable format for analysis. Observations could include quantitative measures, sketches or photographs.

Part C: Report (individual) IAE2, 3, 4; KA1, 4
The practical report should include:

- introduction with relevant earth and environmental concepts and either a hypothesis and variables or an investigable question (IAE1, KA1)
- materials/apparatus*(IAE1)
- method/procedure outlining the steps to be taken*(IAE1)
- identification and management of safety and/or ethical risks*(IAE1)
- results*(IAE2)
- analysis of results, identifying trends, and linking results to concepts (IAE3, KA1)
- evaluation of procedures and data, and identifying sources of uncertainty including reasoning behind modifications to the original design proposal (IAE4)
- conclusion, with justification (IAE3)

The report should be a maximum of 1500 words or the equivalent in multimodal form.
*The four asterisked sections (materials/apparatus, method/procedure, ethical risks, and results) are excluded from the word count.

Due date for the report:

Performance Standards for Stage 2 Earth and Environmental Science

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed earth and environmental science investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear earth and environmental science investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear earth and environmental science investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors, but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of earth and environmental science concepts. Develops and applies earth and environmental science concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of earth and environmental science generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of an earth and environmental science investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of earth and environmental science concepts. Develops and applies some earth and environmental science concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic earth and environmental science information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for an earth and environmental science investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of earth and environmental science concepts. Attempts to develop and apply earth and environmental science concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about earth and environmental science.

Formative Science as a Human Endeavour Investigation – Climate Change

This task has a focus on science as a human endeavour; how science interacts with society.

Select and explore a recent discovery, innovation, issue, or advancement linked to our understanding and management of contemporary variations in Earth's climate. Examples include climate modelling, non-carbon energy technologies, carbon capture and storage, global policies.

Use one or more of the key concepts of science as a human endeavour to develop a focus for your investigation. Make your topic quite specific to enable you to analyse information in depth. For example:

Can global policies be effective in reducing the levels of greenhouse gases? (Communication and collaboration)

How has evidence from proxy data (such as isotopic ratios, ice-core data, palaeobotany, and the fossil record) contributed to the development of models of climate change? (Influence)

How could geosequestration provide sustainable solutions for reducing atmospheric levels of carbon dioxide? (Development)

How can the efficient use of (a renewable energy resource) reduce levels of greenhouse gases? (Application and limitation)

How effective is the international collaboration of scientists through the Intergovernmental Panel on Climate Change (IPCC) in determining achievable targets for the reduction of global warming? (Communication and collaboration)

How effective are general circulation models (GCMs) in predicting future climate change? (Development and Communication and Collaboration)

Can we accurately predict the effects of combustion of fossil fuels on global warming? (Development and Communication and Collaboration)

Select, analyse and synthesise information from different sources to:

- explain the science relevant to the focus of your investigation
- show its connections to science as a human endeavour
- develop and justify your own conclusions.

Prepare a scientific report, which must include the use of scientific terminology and:

- an introduction to identify the focus of the investigation and the key concept(s) of science as a human endeavour that it links to (KA3)
- an explanation of how the focus of the investigation illustrates the interaction between science and society (KA3)
- relevant earth and environmental science concepts or background (KA2)
- a discussion of the potential impact or application of the focus of the investigation, e.g. further development, effect on quality of life, environmental implications, economic impact, intrinsic interest (KA3, IAE3)
- a conclusion with justification (IAE3)
- citations and referencing (KU4)

KA 4 will be assessed throughout the report.

The report, which can be in a format of your choice, should be a maximum of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

Development of capabilities

Critical and Creative Thinking

- devising imaginative solutions and making reasonable predictions
- envisaging consequences and speculating on possible outcomes
- recognising the significance of creative thinking on the development of earth and environmental science knowledge and applications.

Personal and Social

- sharing and discussing ideas about earth and environmental science issues and developments, while respecting the perspectives of others
- recognising the role of their own beliefs and attitudes in gauging the impact of earth and environmental science in society

Ethical Understanding

- using data and reporting the outcomes of investigations accurately and fairly
- acknowledging the need to plan for the future and to protect and sustain the biosphere
- recognising the importance of their responsible participation in social, political, economic, and legal decision-making.

Performance Standards for Stage 2 Earth and Environmental Science

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification.	Develops and applies earth and environmental science concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification.	Develops and applies earth and environmental science concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification.	Develops and applies earth and environmental science concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of earth and environmental science generally effectively, using some appropriate terms, conventions, and representations.
D	Describes data and undertakes some basic interpretation to formulate a basic conclusion.	Develops and applies some earth and environmental science concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic earth and environmental science information, using some appropriate terms, conventions, and/or representations.
E	Attempts to describe results and/or interpret data to formulate a basic conclusion.	Attempts to develop and apply earth and environmental science concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about earth and environmental science.

Science as a Human Endeavour Investigation – Earth Systems

This task has a focus on science as a human endeavour; how science interacts with society. Select and explore a recent discovery, innovation, issue, or advancement linked to our understanding and management of Earth Systems. This may draw on a context suggested in one of the topics or relate to a new context connecting topics. Examples include improving efficiencies of existing energy production and managing urban and industrial waste.

Use one or more of the key concepts of science as a human endeavour to develop a focus for your investigation. Make your topic quite specific to enable you to analyse information in depth.

For example:

Expansion of the Snowy Mountains Hydroelectricity Scheme

Geosequestration to provide sustainable solutions for reducing atmospheric levels of carbon dioxide

Pumped Hydro Energy Storage (PHES) facility at Port Augusta to help stabilise South Australia's energy supply

Development of a renewable energy resource to reduce levels of greenhouse gases

The debate about a high level nuclear waste facility to be built in South Australia

Models that predict the effects of combustion of fossil fuels on global warming

Select, analyse and synthesise information from different sources to:

- explain the science relevant to the focus of your investigation
- show its connections to science as a human endeavor
- develop and justify your own conclusions.

Prepare a scientific report, which must include the use of scientific terminology and:

- an introduction to identify the focus of the investigation and the key concept(s) of science as a human endeavour that it links to (KA3)
- an explanation of how the focus of the investigation illustrates the interaction between science and society (KA3)
- relevant earth and environmental science concepts or background (KA2)
- a discussion of the potential impact or application of the focus of the investigation, e.g. further development, effect on quality of life, environmental implications, economic impact, intrinsic interest (KA3, IAE3)
- a conclusion with justification (IA 3)
- citations and referencing (KA4)

KA 4 will be assessed throughout the report.

The report, which can be in a format of your choice, should be a maximum of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

Performance Standards for Stage 2 Earth and Environmental Science

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed earth and environmental science investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear earth and environmental science investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear earth and environmental science investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors, but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of earth and environmental science concepts. Develops and applies earth and environmental science concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of earth and environmental science generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of an earth and environmental science investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of earth and environmental science concepts. Develops and applies some earth and environmental science concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic earth and environmental science information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for an earth and environmental science investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of earth and environmental science concepts. Attempts to develop and apply earth and environmental science concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about earth and environmental science.

Earth Systems Study

Purpose

This assessment allows you to develop and demonstrate your field observation skills and communicate your knowledge through an Earth Systems Study report. You will undertake an investigation into a particular local environmental issue, concern, initiative, or successful undertaking that can be linked to topics studied in Stage 2 Earth and Environmental Science.

You will develop a research question, then design, plan, undertake, and report on a field-based extended investigation to answer the question. The investigation must include collection and analysis of both primary and secondary data. You will need to be able to analyse the information gathered in terms of the interactions of two or more Earth systems.

Possible research questions include:

- How have mining operations at Olympic Dam influenced the ecosystem of the Coward Springs?
- How has the remediation of the Brukunga Mine improved water quality in the Dawesley Creek?
- Has the increased urban development in the township of Willunga caused a flooding hazard?
- How has the flow of coastal springs been influenced by increased urban development?
- How do rainfall events influence the quality of runoff from a (particular) region?
- What is the water harvesting potential of the (region)?
- What is the solar energy generating potential of (specific region or community)?
- How did climate change during the late Proterozoic - early Palaeozoic influence species diversity in the Flinders Ranges region?
- How did changes in Earth's atmosphere influence the evolution life in the Flinders Ranges region?
- How does evidence from the Hallett Cove region support significant climate change over the past 270 million years?

Description of assessment

Proposal (IAE1) – Individually

You will design an investigation proposal then trial your methods to assist the design of your procedure. You may wish to collect your data independently or during one of the fieldwork excursions.

One draft of the proposal should be submitted for teacher feedback and approval. You may modify your proposal in response to teacher feedback before you undertake your investigation.

Your modified proposal is to be submitted with your report for assessment.

The proposal should include:

- a statement of an investigable question or hypothesis
- a rationale for and an outline of the proposed research approach and method
- a list of equipment required
- the procedure to be followed
- the type of data that will be collected
- a risk assessment that addresses safety, ethical, and legal considerations.

Report – Individually

The report should use scientific terminology and include:

- an introduction to identify the purpose, and relevant background or previous research into the topic (KA1, 4)
- appropriate representation of data, e.g. tables, graphs, maps, charts, photographs, or other illustrations (IAE2)
- analysis of the information gathered in terms of the interactions of two or more Earth systems (IAE3)
- evaluation of procedures and results to identify limitations of, and improvements to, the investigation (IAE4)
- a conclusion, which includes predictions or advice based on findings (IAE3)
- citations and referencing (KA4)

Assessment conditions

The combined word count for the proposal and the report should be a maximum of 2000 words, if written, or the equivalent in multimodal form.

Performance Standards for Stage 2 Earth and Environmental Science

	Investigation, Analysis, and Evaluation	Knowledge and Application
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B	Designs a well-considered and clear earth and environmental science investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science mostly coherently, with effective use of appropriate terms, conventions, and representations.
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Stage 2 Earth and Environmental Science: Program 2: 20 credits

This teaching program articulates with learning and assessment plan 2.

Week	Science Understandings	SIS	SHE	Resources	Assessment Tasks
Term 1 Week 1 -2	Introduction to Stage 2 **Topic 1: Introduction to Earth Systems** • Components and process of the systems: Hydrosphere, atmosphere, biosphere and geosphere & scientific concepts. • Interactions between the systems – carbon, nitrogen, phosphorus and hydrological cycles. Interdependence of earth Systems.	• Practical Investigation: interaction of Earth Systems in the local area.	• Outline of key concepts of Science as a Human endeavour. • SHE Investigation: Case study – Interactions of earth systems and local watercourse management. • Designing an investigation	Refer to the attached document for a list of web-based resources by topic.	Formative Investigation design including: • a hypothesis or inquiry question • types of variables – dependent – independent – factors held constant (how and why they are controlled) – factors that may not be able to be controlled (and why not) • materials required • the procedure to be followed • the type and amount of data to be collected • identification of ethical and safety considerations.
Week 3	• Identifying and measuring change in in systems • Patterns and changes over a variety of time scales • Predicting future changes	• Introduction to field skills – sampling techniques, testing equipment, recording devices, data entry.	• Introduction to citizenship science for data collection, recording & use. • The Precautionary Principal	Web Resources	
Week 4	• Inquiry into Earth systems	• Field Investigation: local area Earth Systems Inquiry. • Scientific methods & measurable evidence.		Field excursion, KESAB water testing kits, lab resources published water quality data.	

Week	Science Understandings	SIS	SHE	Resources	Assessment Tasks
Week 5	• Consideration of local area findings and wider implications.		• Society and science. • Inquiry into an example of how science influences and is influenced by social, economic & political viewpoints and practices.	Developments in water supplies and waste water management.	**AT 1 Practical Design Investigation** **Riparian vegetation along a waterway**
Week 6	**Topic 2: Earth's Resources** • Renewable and non-renewable resource use • Costs and benefits of resource extraction & use, long & short term.		• SHE investigation: Issues associated with the extraction of one or more fossil fuels.		
Week 7 - 8	• Formation of mineral resources. Geological time scales. • Exploration for resources (e.g. iron ore) • Extraction and refining of resources • Issues associated with mineral extraction and mine rehabilitation. • Sustainability of resource extraction and use.	• Practical Investigation: Resource exploration & extraction techniques.	• SHE Investigation: Cradle to the grave measurement of resource impact.		
Week 9 - 11	• Environmental impacts of the extraction and use of mineral resources	• Collection and recording of data. Safety considerations for scientific inquiry.	• SHE Investigation: Case study of impacts of mining and production on ecosystems. Adelaide Brighton Cement.	Adelaide Brighton Cement web site downloadable documents & wetland.	**AT 2 Skills and Application Task: Topics 1and2**
Term 2 Week 1	**Topic 3 Earth's Sustainable Future** • Renewable sources of energy and mineral resources	• Practical Investigation – generating, storing and using energy	• Pumped hydro for energy storage • Society & energy resource demands, debates and change.	Web based research Aquifer water resource use. & recharge. DEW&NR web site	

Week	Science Understandings	SIS	SHE	Resources	Assessment Tasks
Week 2	• Soil formation and structure • Sustainability of soil and water	• Practical investigation – soil structure, texture & organic carbon.	• Development of sustainable soil management in Agriculture.		
Week 3 - 5	• Availability and quality of global fresh water • Recycling of stormwater and effluent water	• Field Investigation wetlands and water quality.	• SHE Investigation: catchment management and water.	Department of Environment, Water & Natural Resources	**AT 1 Field Investigation on wetlands.**
Week 6 - 7	• Pollution of groundwater and waterways	• Field Investigation – local catchment area and creek study		KESAB Water Quality Local, State & commonwealth Government materials	**AT 1: SHE Investigation**
Week 8	• Effective use of energy resources	• Collaborative investigation – estimate individual & class ecological footprint.	• SHE investigation – identify ways to reduce our ecological footprint • Understanding of the complex ways in which science interacts with society.	Web ecological Footprint calculators.	
Week 9	• Renewable and non-renewable energy resource use and sustainability.		• SHE investigation – impacts of introducing renewable energy to local ecosystems		**AT 2 Topics Test Earth's Sustainable Future**
Week 10	**Topic 4 Climate Change** • The Carbon cycle • Geological time changes the Earth's atmosphere • Natural Greenhouse effect and greenhouse gases	• Practical Investigation: modelling the evolution of the Earth's atmosphere	• Scientific discovery and Greenhouse. Society & Greenhouse. • Stratospheric ozone as an example of the interaction of science and society.	Web downloadable diagrams. DVD Crude-The incredible Story of Oil Understanding Science Web site	
Term 3 Week 1	• Astronomical cycles and sunspot activity • Tectonic influences on Climate	• Investigation: Glacial & Interglacial periods		NASA Web resources	

Week	Science Understandings	SIS	SHE	Resources	Assessment Tasks
Week 2	• Oceans absorb large amounts of solar radiation • Ocean circulation • Shallow and deep water ocean currents • Thermohaline circulation			Web Resources	**AT 2 Skills and Applications Task:** **Oceans**
Week 3	• Human activities and climate • Enhanced greenhouse effect	• Investigation:		Web Resources	
Week 4	• Effects of climate change on Earth Systems	• Investigation: Modelling the Earth's Energy balance	• SHE Investigation: Managing the health effects of climate change		
Week 5	Earth Systems study	• Design Earth Systems Study			**AT 3 Earth Systems Study**: Individual research question and plan
Week 6	Earth Systems study	• Conduct Earth Systems Study*			**Earth Systems study:** Design and risk assessment
Week 7	Earth Systems study	• Analyse data and complete report			
Week 8	• Evidence for climate change • Climate proxies	• Practical investigation: climatic analysis using foraminifera • Practical investigation: oxygen isotopes – a proxy for sea surface temperatures		Web Resources	
Week 9	• Models for predicting climate change • Local, national and international responses to climate change	• Prepare for Earth Systems Study	• SHE Investigation: Paris and the IPCC	UN Framework on climate Change Website	**External Earth Systems Study Due**.
Week 10	Prep for oral presentation on climate change				
Term 4 Week 1					
Week 2					**AT 2 SAT: Climate change Presentation**

Stage 2 Earth and Environmental Science – Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio Weighting 30%	**Field Investigation**: Students will work in small groups to collect data that will help answer a question about the effect of a variable, such as salinity, water flow rate, flooding, introduced species) on an ecological characteristic of a wetland, (such as the distribution of a particular species in the area, acid-sulfate levels in the soil or native fish populations). Students individually analyse the shared data and write a report.	2,3,4	1,4	Field data collection 2 lessons. Lab lesson 1 lesson. 1500 word written report (excluding method/procedure, ethical risks & results), 10 minutes for an oral presentation or the equivalent in multimodal form.
	Practical Design Investigation: Students design an investigation to investigate how changes in the riparian vegetation along a waterway are linked to changes in one particular factor. Students deconstruct the problem in pairs to select a testable factor and consider a method to test their hypothesis. They individually design an investigation and then carry out one in pairs. Students produce an individual report.	1,2,3,4	2,4	The report should be of a maximum length of 1500 words excluding materials/apparatus, methods/procedure, ethical risks, and results.
	SHE Investigation: Students investigate a recent discovery, innovation, issue, or advancement linked to *Earth's Resources*, that focuses on Science as a Human Endeavour. This investigation could focus on a context suggested in the core topics or relate to a new context. Presentation is in a format of the student's choice.	3	1,3,4	2 weeks to gather information and write an individual report. Up to a maximum of 1500 words or a maximum of 10 minutes in total for an oral presentation, or the equivalent in multimedia form.
Assessment Type 2: Skills and Applications Tasks Weighting 40%	**Short answer responses on topics 1 and 2**: Earth's Systems and Earth Resources. Students apply their knowledge, understanding to different scenarios and data, in order to form and justify conclusions using appropriate terms and conventions.	3,4	2,3	90 minute timed test under supervision excluding reading time.
	Topic Test Topic 3: Earth's Sustainable Future. Students apply knowledge, analyse data, and form conclusions using appropriate terms and conventions. They do this in a range of question types including short answer and extended response.	3	1,2,3,4	90 minute timed test (excluding reading time) under supervision.
	Oceans Assignment Three activities are undertaken to demonstrate the effect of oceans on weather systems.	2,3	3	90 minutes of class time over 2 lessons. All work submitted electronically.
	Oral presentation: Students demonstrate knowledge and understanding of Topic 4: Climate Change. They apply this knowledge, analyse data, and form conclusions using appropriate terms and conventions.	3	1,4	Maximum of 10 minutes. The text of their presentation is submitted electronically.
Assessment Type 3: Earth Systems Study Weighting 30%	Students undertake one fieldwork investigation into a particular local environmental issue, concern, initiative, or successful undertaking that can be linked to topics studied in Stage 2 Earth and Environmental Science. Students develop a research question, then design, plan, undertake, and report on a field-based extended investigation to answer the question. Students analyse their information in terms of the interactions of two or more Earth systems.	1,2,3,4	1,2,3,4	The report should be a maximum of 2000 words, if written, or the equivalent in multimodal form.

Eight assessments. *Please refer to the Stage 2 Earth and Environmental Science subject outline.*

Assessment Type 1: Investigations Folio

Field Investigation

The aim of this investigation is to collect data that will help answer a question about the effect of a variable, such as salinity, water flow rate, flooding, introduced species) on an ecological characteristic of a wetland, (such as the distribution of a particular species in the area, acid-sulfate levels in the soil or native fish populations)

Students work in groups to make observations and collect data in an allocated section of a wetland. The sampling techniques chosen will depend on the question under investigation.

Each student individually analyses the data and presents a report, drawing on data collected from fieldwork and other sources.

The practical/field report should include:

- *introduction with relevant earth and environmental concepts and either a hypothesis and variables or an investigable question*
- *materials/apparatus**
- *method/procedure outlining the steps to be taken**
- *identification and management of safety and/or ethical risks**
- *results**
- *analysis of results, identifying trends, and linking results to concepts*
- *evaluation of procedures and data, and identifying sources of uncertainty*
- *conclusion, with justification.*

The report should be a maximum of 1500 words if written, 10 minutes for an oral presentation or the equivalent in multimodal form.
*The four asterisked sections (materials/apparatus, method/procedure, ethical risks, and results) are excluded from the word count.

This field report is to be attached to this task sheet and submitted electronically.

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Assessment Type 1: Investigations Folio

Practical Design Investigation

Purpose: To investigate how changes in the riparian vegetation along a waterway are influenced by changes in one particular biotic or abiotic factor.

In pairs

Select a testable factor. Examples include fish populations, algal growth, water temperature, water flow, and turbidity. Research the role of this factor in the interaction of Earth systems in the area under investigation.

Then deconstruct the parts of this problem to formulate a hypothesis to test and determine the most appropriate method for investigation.

In a preliminary visit to the waterway, trial your procedure. Record your observations and make notes about possible modifications to the procedure that could improve the efficiency of collection of your data.

Individually

Design your own investigation. Your design should include:

- *the independent and dependent variables, factors to be held constant and factors that may not be able to be controlled*
- *the materials required and a detailed procedure*
- *a justification of the details of your procedure, using the results of your trial*
- *identification of ethical and safety considerations.**

Submit your design for teacher feedback.

In pairs

Select, and carry out, one investigation and record your observations.

Individually

Your practical report should include:

- *introduction that includes the hypothesis and variables and a description of the interactions between the Earth systems in the area under investigation*
- *materials/apparatus**
- *method/procedure outlining the steps to be taken**
- *identification and management of safety and/or ethical risks**
- *results**
- *analysis of results, identifying trends, and linking results to the interactions between the relevant Earth systems*
- *evaluation of procedures and data, and identifying sources of uncertainty*
- *conclusion, with justification.*

The report should be a maximum of 1500 words or the equivalent in multimodal form.

*The four asterisked sections (materials/apparatus, method/procedure, ethical risks, and results) are excluded from the word count.

Performance Standards for Stage 2 Earth and Environmental Science

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Science as a Human Endeavour Investigation

Earth's Resources

In this task you have the opportunity to investigate a contemporary example of how science interacts with society.

Select and explore a recent discovery, innovation, issue, or advancement linked to *Earth's Resources*.

For example;

- Use the article by Stephen Long, 28 Feb 2017, *Methane emissions from coal seam gas development raise climate change concerns*, at http://www.abc.net.au/news/2017-02-28/methane-emissions-from-coal-seam-gas-climate-change/8310932 as the basis for your discussion of the key concept:

  New technologies improve the efficiency of scientific procedures and data collection and analysis. This can reveal new evidence that may modify or replace models, theories, and processes

- Use the development of hydroelectricity in Brazil as a basis for discussion of the key concept:

  The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation.

Use a variety of sources of information that enable an in depth discussion of your topic.

Prepare a scientific report, which must include the use of scientific terminology and:

- *an introduction to identify the focus of the investigation and the key concept of science as a human endeavour that links to the investigation.*
- *an explanation of how the focus of the investigation illustrates the interaction between science and society*
- *relevant earth and environmental science concepts or background*
- *a discussion of the potential impact or significance of the focus of the investigation, e.g. potential of new development, effect on quality of life, environmental implications, economic impact, intrinsic interest*
- *a conclusion with justification*
- *citations and referencing.*

You can choose the format for your report. For example;

an article for a scientific publication, a letter to the editor, a multimedia presentation to an energy company.

The report should be a maximum of 1500 words if written or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

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Methane emissions from coal seam gas development raise climate change concerns

By Stephen Long http://www.abc.net.au/news/2017-02-28/methane-emissions-from-coal-seam-gas-climate-change/8310932 28 Feb 2017

Click on the GIF: The FLIR video recorder can detect invisible gases like methane. **Map:** Chinchilla 4413

For teacher use

Development
New technologies improve data collection and analysis. This can reveal new evidence that may modify or replace models, theories, and processes.

Limitation
The use of scientific knowledge may have unexpected consequences; this requires monitoring, assessment, and evaluation of risk and provides opportunities for innovation.

Limitation
Science informs public debate; at times, there may be complex, unanticipated variables or insufficient data that may limit possible conclusions.

— let alone far more ambitious goals likely to come.

Assessment Type 2: Skills and Applications Task

This task provides the opportunity to demonstrate your understanding of how oceans can affect weather systems.

All of your work for this task is to be submitted electronically using *MS Word* and *MS Excel*. All activities are completed under teacher supervision in class. Activity 2 can be started while Activity 1 is underway.

1. Practical Activity
In groups, construct models of the ocean and the land to test the following hypothesis:

> "The warming and cooling rates of land are greater than those of the ocean."

Materials (per group)

- 2 buckets or deep foil trays
- water
- sand
- 2 temperature sensors
- 2 retort stands

Procedure (work in groups)

- Fill one bucket with sand and one bucket with water. Make sure the buckets are filled to the same level. Use retort stands to position the temperature sensors 2 – 3 cm under the surface in each bucket. Leave both buckets in the shade until they reach the same temperature.
- Once the temperature in both buckets is the same, put them in direct sunlight. Record the temperature every two minutes until a clear trend in the data is seen. Print out one copy of the graph of temperature versus time for each group member.
- Move the buckets back into the shade. Record the temperature every two minutes until a clear trend is seen. Print the graph for each group member.

Analysis (work individually)
Attach the printouts of the two graphs.

1. Compare the rate of change in temperature for the two buckets as they warmed and as they cooled.

2. Use your results to explain whether the hypothesis is confirmed, refuted or uncertain.

3. Discuss the limitations of your model in representing land and ocean.

2. Data analysis activity

Use the following information to test the following hypothesis:

> The warming and cooling rates of land are greater than those of the ocean at similar latitudes in Australia.

Three regions in Australia with latitude of 35°S are Adelaide, Murray Bridge and Albany. Their locations are shown as ⇦ on the map below:

http://www.nationsonline.org/oneworld/map/australia-map.htm

The 7-day weather forecast, for a week in March, is given for each region on the next page. Use this information to answer the questions that follow.

MURRAY BRIDGE 7-DAY WEATHER FORECAST

	Wed Mar 8	Thu Mar 9	Fri Mar 10	Sat Mar 11	Sun Mar 12	Mon Mar 13	Tue Mar 14
Summary	Sunny	Mostly sunny	Sunny	Possible shower	Clearing shower	Sunny	Mostly sunny
Maximum	35°C	35°C	32°C	26°C	23°C	25°C	30°C
Minimum	15°C	16°C	15°C	15°C	15°C	13°C	14°C
Chance of Rain	20%	10%	90%	90%	50%	10%	10%
Rain Amount	< 1mm	< 1mm	1-5mm	1-5mm	1-5mm	< 1mm	< 1mm
UV Index	Very High	Very High	Very High	Very High	Very High		
Frost Risk	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Wind Speed	9am 11 km/h, 3pm 11 km/h	9am 9 km/h, 3pm 20 km/h	9am 12 km/h, 3pm 18 km/h	9am 14 km/h, 3pm 17 km/h	9am 23 km/h, 3pm 30 km/h	9am 18 km/h, 3pm 22 km/h	9am 12 km/h, 3pm 19 km/h
Wind Direction	9am ENE, 3pm NE	9am SSW, 3pm SSW	9am S, 3pm SSW	9am NNE, 3pm WNW	9am SW, 3pm SSW	9am S, 3pm SSW	9am S, 3pm S
Relative Humidity	55%	17%	63%	27%	70%	26%	56%	40%	79%	57%	77%	45%	74%	40%
Dew Point	12°C	7°C	16°C	14°C	14°C	11°C	10°C	11°C	14°C	14°C	13°C	12°C	14°C	15°C

ADELAIDE AP 7-DAY WEATHER FORECAST

	Wed Mar 8	Thu Mar 9	Fri Mar 10	Sat Mar 11	Sun Mar 12	Mon Mar 13	Tue Mar 14
Summary	Sunny	Sunny	Sunny	Possible shower	Clearing shower	Mostly sunny	Mostly sunny
Maximum	31°C	31°C	30°C	26°C	24°C	26°C	28°C
Minimum	18°C	19°C	18°C	17°C	16°C	16°C	17°C
Chance of Rain	5%	5%	80%	80%	70%	20%	5%
Rain Amount	< 1mm	< 1mm	1-5mm	1-5mm	< 1mm	< 1mm	< 1mm
UV Index	Very High	Very High	Very High	Very High	Very High		
Frost Risk	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Wind Speed	9am 6 km/h, 3pm 18 km/h	9am 5 km/h, 3pm 20 km/h	9am 8 km/h, 3pm 19 km/h	9am 11 km/h, 3pm 20 km/h	9am 20 km/h, 3pm 30 km/h	9am 14 km/h, 3pm 22 km/h	9am 9 km/h, 3pm 18 km/h
Wind Direction	9am E, 3pm SW	9am ESE, 3pm SW	9am SE, 3pm SW	9am ENE, 3pm WSW	9am SSW, 3pm SSW	9am S, 3pm S	9am SE, 3pm SSW
Relative Humidity	47%	40%	47%	39%	54%	37%	46%	52%	70%	60%	66%	54%	65%	49%
Dew Point	11°C	15°C	12°C	15°C	13°C	14°C	10°C	15°C	13°C	15°C	13°C	16°C	14°C	16°C

ALBANY 7-DAY WEATHER FORECAST

	Wed Mar 8	Thu Mar 9	Fri Mar 10	Sat Mar 11	Sun Mar 12	Mon Mar 13	Tue Mar 14
Summary	Showers	Possible shower	Possible shower	Mostly sunny	Mostly sunny	Possible thunderstorm	Possible shower
Maximum	21°C	21°C	21°C	21°C	26°C	25°C	25°C
Minimum	17°C	17°C	17°C	16°C	15°C	19°C	18°C
Chance of Rain	40%	40%	5%	5%	70%	60%	70%
Rain Amount	< 1mm	< 1mm	< 1mm	< 1mm	< 1mm	1-5mm	1-5mm
UV Index	Very High	Very High	Very High	Very High	Very High		
Frost Risk	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Wind Speed	9am 13 km/h, 3pm 24 km/h	9am 20 km/h, 3pm 26 km/h	9am 22 km/h, 3pm 27 km/h	9am 18 km/h, 3pm 24 km/h	9am 17 km/h, 3pm 17 km/h	9am 15 km/h, 3pm 20 km/h	9am 17 km/h, 3pm 28 km/h
Wind Direction	9am SSE, 3pm SSE	9am SE, 3pm SE	9am SE, 3pm SE	9am SE, 3pm SE	9am ENE, 3pm E	9am NNW, 3pm WNW	9am NNW, 3pm NW
Relative Humidity	76%	66%	72%	69%	63%	58%	60%	54%	63%	46%	75%	57%	66%	46%
Dew Point	15°C	14°C	15°C	15°C	13°C	12°C	12°C	11°C	13°C	13°C	18°C	16°C	15°C	12°C

1. The following data table has been constructed to display the temperatures for Adelaide and Murray Bridge for this week.

	Adelaide			Murray Bridge		
	max (°C)	min (°C)	range (°C)	max (°C)	min (°C)	range (°C)
Wed	31	18	13	35	15	20
Thu	31	19	12	35	16	19
Fri	30	18	12	32	15	17
Sat	26	17	9	26	15	11
Sun	24	16	8	23	15	8
Mon	26	16	10	25	13	12
Tue	28	17	11	30	14	16
AVERAGE	28.0	17.3	10.7	29.4	14.7	14.7

2. (a) Use *MS Excel* to draw a well-labelled graph to show the range of temperatures in Adelaide and Murray Bridge over the seven days.

   (b) Use your graph to explain whether the hypothesis is confirmed, refuted or uncertain.

3. Complete a similar data table in *MS Excel* to display the temperatures for Adelaide and Albany for this week. Use the functions in *MS Excel* to calculate the ranges and average values.

4. (a) Use *MS Excel* to draw a well-labelled graph to show the range of temperatures in Adelaide and Albury over the seven days.

   (b) Use your graph to describe the similarity and difference in temperatures between these two regions.

   (c) Discuss one factor that could contribute to the difference in temperatures between these two regions.

3. Ocean research

This activity focuses on science as a human endeavour.

The Global Ocean Observing System
http://www.goosocean.org/

(a) Use information from this website to discuss the reasons for setting up this global observation system.

(b) Describe examples of how the work of the people at GOOS illustrates science as a human endeavour.

Integrated Marine Observing Systems
http://imos.org.au/argo.html

Argo Floats

Argo is an international collaboration that collects high-quality temperature and salinity profiles from the upper 2000m of the ice-free global ocean and currents from intermediate depths. The data come from battery-powered autonomous floats that spend most of their life drifting at depth where they are stabilised by being neutrally buoyant at the "parking depth" pressure by having a density equal to the ambient pressure and a compressibility that is less than that of sea water. At present there are several models of profiling float used in Argo. All work in a similar fashion but differ somewhat in their design characteristics. At typically 10-day intervals, the floats pump fluid into an external bladder and rise to the surface over about 6 hours while measuring temperature and salinity. Satellites or GPS determine the position of the floats when they surface, and the floats transmit their data to the satellites. The bladder then deflates and the float returns to its original density and sinks to drift until the cycle is repeated. Floats are designed to make about 150 such cycles.

http://www.argos-system.org/argos/why-choose-argos/

Use information from the sites above and other websites to answer the following questions about Argo.

(c) Describe the purpose of Argo(s) and how it helps the scientific community.

(e) Describe how an Argo float collects information and how this information is used.

Performance Standards for Stage 2 Earth and Environmental Science

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed earth and environmental science investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear earth and environmental science investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of earth and environmental science concepts. Develops and applies earth and environmental science concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of earth and environmental science mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear earth and environmental science investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors, but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of earth and environmental science concepts. Develops and applies earth and environmental science concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of earth and environmental science generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of an earth and environmental science investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of earth and environmental science concepts. Develops and applies some earth and environmental science concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic earth and environmental science information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for an earth and environmental science investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of earth and environmental science concepts. Attempts to develop and apply earth and environmental science concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about earth and environmental science.

Stage 2 Physics Program 1

This planner articulates with learning and assessment plan 1

Term 1				
Week	**Section**	**Topic**	**Formative tasks**	**Summative tasks**
1	**Topic 1: Motion and Relativity**	**Projectile motion**: Use of equations of motion in horizontal and vertical components to solve problems involving time of flight, range, and resultant velocity. Vector problems.		
2		Factors affecting the drag force and the effect that drag has on the motion of projectiles in sports, and the study of aerodynamics.		
3		**Forces and momentum:** Use of force and acceleration vectors and both $\vec{F} = m\vec{a}$ and the momentum form of Newton's Second Law of Motion, including vector subtraction.		
4		Conservation of momentum questions, including multi-image problems. Momentum conservation in rocket propulsion and space craft, including solar sails and ion drives. (**SHE**) Links made between momentum and the Standard Model-neutrinos.		
5		**Circular motion and gravitation.** Use of vectors and formulae to solve problems involving centripetal acceleration and the force causing it. **SHE**: Banked curves, amusement park rides, high-speed trains. Review practical skills.	Formative Test: Projectile motion, forces, and momentum.	
6		Gravitational force formula and the concept of a gravitational field.	**SIS** Formative Practical: Centripetal force	
7		Explore detection of existence of stars, predicting dark matter. Properties of satellite orbits and uses of satellites. (**SHE**)	**SIS** Formative Practical: Projectiles	
8		Kepler's Laws of motion, comets and planets. Use of formulae to calculate periods, radii, altitudes and speeds of satellites. Calculating the mass of the sun or Saturn.	**SIS** Formative Practical: Speed of sound (resonance)	
9		**Einstein's relativity:** Frames of reference, constancy of the speed of light. Special theory of relativity and the behaviour of objects at high speeds.	Formative Practical submitted to give feedback	
10		Simultaneous events, Einstein's formulae, time dilation, length contraction, effects on mass. Evidence/applications involving relativity, such as muons and GPS. (**SHE**)	**SIS** Formative Practical: Teltron tube	**Test 1: Motion and relativity**
Term 2				
11	**Topic 2:**	**Electric fields:** Coulomb's Law and the electric field concept. Electric field problems and electric field diagrams. Superposition of electric forces and fields.		

Week		Content	Formative tasks	Summative tasks
1	**Topic 2: Electricity and Magnetism** (continued)	Applications of electric fields and electrostatic shielding, including electrostatic loudspeakers, corona discharge, shark shields, Faraday cages, photocopiers. (**SHE**)		**Practical Design-Snow Globes**
2		**Motion of charged particles in electric fields:** Concept of work done by an electric field, potential difference and energy changes of charged particles moving in a vacuum, and the electronvolt unit. Application of the motion of ions in ion thrusters, and particle accelerators, such as the cyclotron. (**SHE**)		
3		Use of formulae to determine force, acceleration, and resulting motion of charged particles in an electric field. **SHE**: Cathode ray tubes, discovery of fundamental particles.		**Select SHE focus** & **use Internet**
4		**Magnetic fields:** Moving charges produce magnetic fields. Magnitude and direction of the magnetic field/force around a current-carrying conductor. Research: focus and planning.		
5		**Motion of charged particles in magnetic fields:** Solve problems about force, current, angle, magnetic field strength and direction for a current-carrying conductor in a magnetic field. **SHE**: Loudspeakers and maglev trains.		**First drafts of SHE Investigation**
6		Force on a moving charged particle in a uniform magnetic field. Solve problems involving the circular path of charged particles in magnetic fields. Applications of charges moving in a magnetic field, such as mass spectrometer and electron microscopes. Use of formulae to explore properties of a cyclotron.		
7		**Electromagnetic induction:** Concepts of magnetic flux and electromotive force (emf). Explaining and using Faraday's Law and Lenz's Law to solve problems.		
8		Applications of electromagnetic induction, including generators, transformers and induction stoves. Structure of transformers and generators. Use formula to solve problems on transformers. (**SHE**)		**SHE Investigation Report due**
9		**Wave behaviour of light:** Production of electromagnetic waves from oscillating charges. The wave model of light and the link between the frequency of electromagnetic waves and oscillating charges. Applications of electromagnetic waves and polarised waves.		**Test 2: Electricity and Magnetism**
10		Revision	Mid-Year Trial Exams	
Term 3				
1	**Topic 3: Light and Atoms**	Concepts of monochromatic, coherent and incandescent light. Phase relationships, constructive and destructive interference. Description and explanation of two source patterns, including the role of diffraction.	**SIS** Formative Practical: Spectra	
2		Use of formulae to solve problems for two source interference patterns. Applications of interference, including data storage. Determination of wavelength of light using interference.	**SIS** Formative Practical: Wavelength of LASER	

Week		Content	Formative tasks	Summative tasks
3		Description and explanation of transmission diffraction gratings. Use of formulae to solve problems for diffraction gratings. Determination of wavelength of light using interference/spectroscopy.	**SIS** Formative Practical: Photoelectric effect	
4		**Wave-Particle duality:** Properties of photons. Investigate and explain the photoelectric effect and its features. Solve problems about the photoelectric effect, using formulae. Explore applications of the photoelectric effect, such as photomultiplier tubes, smoke detectors, charged coupled devices, and solar cells. (**SHE**)	**SIS** Formative Practical: Spectrometer	
5		Describe and explain the production of X-rays and their properties. Explore examples of the application of X-rays and their uses. Explore attenuation, penetrating power, and minimum exposure time for X-ray machines. Explain features of the X-ray spectrum and use formula to solve problems. Features of a simple X-ray tube.	**SIS** Formative Practical: Light intensity and distance	
6		Discuss the wave behaviour of particles and solve problems using appropriate formulae. Explore the evidence for the wave behaviour of particles. **SHE**: Electron microscopes.		**Practical Design- Magnetic Field**
7		**The structure of the atom.** Investigate and compare continuous emission spectra, line emission spectra, and line absorption spectra. Energy level diagrams of hydrogen, energy transitions, and the regions of the electromagnetic spectrum of the photons produced/absorbed.		
8		Excited states, ionisation and fluorescence. Stimulated emission, metastable states and population inversions. Explore the properties and applications of lasers and fluorescence.		**Test 3: Science Inquiry Skills Test**
9		**Standard Model:** Fundamental particles- gauge bosons, leptons and quarks. Gauge bosons mediate four fundamental forces. Study the 6 types of quarks and how particles such as baryons are made of quarks and leptons.		
10		Definition of Lepton & Baryon numbers, conservation laws in reactions. Antimatter & antiquarks. Explore the Large Hadron Collider research & changes in understanding of the standard model. Explore PET scanners and impacts of SAHMRI cyclotron. Annihilation.		**Test 4: Light and Atoms**
Holiday revision day at school **Revise Motion and relativity**				
Term 4				
1		Revision: Electricity and Magnetism		
2		Revision: Light and Atoms		
3		Revision	Trial Exam	Trial Exam

Stage 2 Physics (20-credits)

Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio **Weighting 30%**	**Practical Design Investigation (Drag):** Part A/B-Students work in small groups to deconstruct a problem regarding the snow used in snow globes. Each student then designs an experiment to test the relationship between a variable they choose to investigate associated with a property of the snow and its drag when released in a column of water. They state a hypothesis and identify variables and develop their own procedure to test their hypothesis. Part C/D-Students work in groups to carry out *one* of the procedures designed by a member of the group, to manipulate apparatus using safe and ethical work practices-students have the option of using a prepared method from the teacher. They collaborate to obtain, record, and represent data, then individually interpret and analyse the data using appropriate technology. Students use graphical analysis of the data to assist in their interpretation. They evaluate the procedure and their effects on the results, and formulate and justify a conclusion, taking into account the limitations of the investigation.	1, 2, 3, 4	2,4	Students deconstruct a problem in small groups and then prepare their own design, initially under supervision during a double lesson, but submitted within one week to a maximum word count of 250 words. Each group discusses their individual designs and comes to a consensus to select the investigation to carry out. They then undertake the investigation under supervision the following double lesson. Each student electronically submits an individual written or multimedia report of their group investigation based on the requirements specified in the subject outline and to a maximum word count of 1250 words, or equivalent, excluding the apparatus, method, safety, and results. They have one more week to complete this.
	Practical Design Investigation (Magnetic Flux Density): Students design an experiment to test the effect of a variable on the magnetic flux density around a single, current-carrying conductor or that at the pole of a solenoid. They consider varying factors such as the current, distance from the conductor/pole, or number of turns on the solenoid. They state a hypothesis and identify variables and safety aspects, then develop and use their own procedure, to manipulate apparatus using safe and ethical work practices. They collaborate to obtain, record, and represent data, then individually interpret and analyse it using appropriate technology. Students use graphical analysis of the data to assist in their interpretation. They evaluate the procedure and the results, and formulate and justify a conclusion, taking into account the limitations of the investigation.	1, 2, 3, 4	4	Students plan their investigation before the practical lesson. They have one 90-minute double lesson to carry out their investigation, collect their data, and begin their multimedia or written report. Students have one week to complete and electronically submit an individual, written report based on the requirements specified in the subject outline and to a maximum word count of 1500 words, or equivalent excluding the apparatus, method, safety, and results.
	Science as a Human Endeavour Investigation: Each student selects an invention from a supplied list and then formulates a focus to explore related to an aspect of physics and connected to one of the key concepts of Science as a Human Endeavour described in the subject outline. They gather information from different sources, identify and discuss the significance of the focus, analyse their findings, and develop and justify their conclusions. Students use the literacy skills of physics to explain links between data, concepts, and issues. They electronically communicate their overall findings in a final report, including an explanation of the impact or significance of the focus of their exploration.	3	1, 3, 4	Students have 2 lessons under supervision and 5 weeks of their own time to complete the report. During a supervised double internet lesson, students individually form a focus to explore, begin locating information and test the suitability of the focus. Students have two weeks to gather their research information, make notes, and show one draft about the focus to discuss their progress with the teacher. They will electronically submit a final report to a maximum of 1500 words 3 weeks later.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 2: Skills and Applications Tasks **Weighting 40%**	**Motion and Relativity Test**: Students demonstrate knowledge and understanding of the concepts in projectile motion, forces and momentum, circular motion and gravitation, and relativity. They apply this knowledge to solve problems, using correct terminology, formulae, and equations. Students analyse problems related to these subtopics and present solutions using appropriate physics terms and conventions. Questions vary from routine to complex and include new and familiar contexts. Questions related to science as a human endeavour are also included.		1, 2, 3, 4	Written, under test conditions 80 minutes Formula sheet provided
	Electricity and Magnetism Test: Students demonstrate knowledge and understanding of the concepts covered in electric fields, magnetic fields, motion of charged particles in electric and magnetic fields, and electromagnetic induction. They apply this knowledge to solve problems using correct terminology, formulae, and equations. Students analyse problems related to these subtopics and present solutions using appropriate physics terms and conventions. Questions vary from routine to complex and include new and familiar contexts. A science inquiry skills question is also included.	2, 3	1, 2, 4	Written, under test conditions 80 minutes Formula sheet provided
	Light and Atoms test: Students demonstrate knowledge and understanding of the key ideas and intended student learning covered in wave behaviour of light, wave-particle duality, the structure of the atom, and the Standard Model. They apply this knowledge to solve problems in a test using correct terminology, formulae and equations. Students analyse problems related to the wave behaviour of light, wave-particle duality, the structure of the atom, and induced nuclear reactions and present solutions using appropriate physics terms and conventions. Questions vary from routine to complex and include new and familiar contexts.		1, 2, 4	Written, under test conditions 80 minutes Formula sheet provided
	Science Inquiry Skills Test: Students respond to question(s), including a procedure, labelled diagram, and example data. They demonstrate their skills in representing and interpreting the data, forming a conclusion, and critically evaluating a procedure.	2, 3, 4	4	Written, under test conditions 40 minutes
External Examination **Weighting 30%**	2-hour examination	Questions of different types cover all Stage 2 topics and science inquiry skills. Some questions may require students to integrate their knowledge from more than one topic and show an understanding of science as a human endeavour.		

Eight assessments including the external examination. *Please refer to the Stage 2 Physics subject outline.*

Stage 2 Physics Investigation Folio Task:

Deconstruction and Design Task-Snow Globe

Introduction and Purpose of Task:

Manufacturers believe that one of the important qualities of snow-globes is that the 'snow' falls slowly back to the base after it has been shaken up.

Read the information below and consider the problem:

"What is the best 'snow' to use in a liquid-filled snow-globe?

Libux77 | Dreamstime.com - <a href="https://www.dreamstime.com/stock-photography-snowglobe-winter-christmas-landscape-image35745652#res13417322">

The purpose of this task is to

- deconstruct the problem by considering some of the issues that need to be addressed
- design a detailed method to the test a hypothesis you have constructed based on the problem
- complete a practical to analyse data and evaluate the method used, and make justified conclusions considering the limitations of the experiment.

Part A: Deconstruct the problem.

Discuss with your group the factors that the manufacturers would need to take into account when planning what 'snow' and liquid to use.

You may wish to consider, for example:

- What factors could affect the time it takes for the 'snow' to reach the base?
- Is there a maximum or minimum size that should be used and, if so, why is this important?
- Is any shape acceptable to use as snow?

Summarise these for inclusion in the introduction of your design.

Part B: Design

In your group, discuss how you could test some of these factors in the laboratory.
Individually, select one of the factors to test.

Prepare the design for an appropriate investigation and include the following:

- Introduction
- aim and hypothesis
- variables, factors that must be controlled, cannot be controlled
- safety and other risks,
- ethical considerations if applicable
- list of materials
- detailed procedure
- suggest what the results would be if the hypothesis was supported
- any limitations of the experiment or the conclusions that could be drawn, with justification
- Use your physics knowledge to explain some of the issues or results
- references for any research undertaken

Submit your design for assessment and feedback.

Part C: Conduct an experiment

Collaboratively, you will work in small groups to select one of the methods designed by yourself or a group member and undertake the investigation using. Alternatively, you may use the falling plasticene practical task provided by your teacher.

You will work together safely and collaboratively to collect data.

Part D: Write your report

Individually, you will write a report with the following:

- results (table and graph)
- discussion (analysis and evaluation)
- conclusion (justified and any limitations)

Part B, the design, must be attached to the report of your results.

Assessment conditions for this task:

Part A and B: Supervised small group discussions to deconstruct the problem and do some planning during a double lesson. One week will be provided to complete the written design. Internet and other sources of information may be used. Word count for Part B, excluding the method, safety and or ethical considerations and references is approximately 250 words.
Due Date for design: _____

Part C: Collaborative completion of the investigation to collect data, then an individual report with the results, discussion and conclusion. The maximum word count for Part D is approximately 1250 words, depending on the length of Part B.

The combined maximum word count for Parts B and D is 1500 words.

Due Date for Part D: _____

Assessment Design Criteria

Part A:

Investigation, Analysis and Evaluation: IAE1

Part B:

Investigation, Analysis and Evaluation: IAE 2, IAE3, IAE4

Knowledge and Application: KA2, KA4

Note for teachers:

Teachers may choose to provide students with a method to complete the plasticene investigation (see below) and assess IAE1 using Part A and B only.

In this instance, students would only submit a final report but on the whole plasticene investigation with a report that includes:

- introduction with relevant physics concepts and either a hypothesis and variables or an investigable question
- materials/apparatus*
- method/procedure that outlines the steps to be taken*
- identification and management of safety and/or ethical risks*
- results*
- analysis of results, identifying trends, and linking results to concepts
- evaluation of procedures and data, and identifying sources of uncertainty
- conclusion, with justification.

The report should be a maximum of 1500 words, if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

*The four asterisked sections (materials/apparatus, method/procedure, ethical risks, and results) are excluded from the word count.

Students additionally include Part B which is not included in the word count.

Performance Standards for Physics

	Investigation, Analysis and Evaluation	Knowledge and Application
A	Designs a **logical, coherent,** and **detailed** physics investigation. Obtains, records, and represents data, using **appropriate** conventions and formats **accurately and highly effectively.** **Systematically** analyses and interprets data and evidence to formulate **logical** conclusions with **detailed** justification. **Critically** and **logically** evaluates procedures and their effect on data.	Demonstrates **deep and broad** knowledge and understanding of a **range** of physics concepts. Develops and applies physics concepts **highly effectively** in new **and** familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of physics **coherently,** with **highly effective** use of appropriate terms, conventions, and representations.
B	Designs a **well-considered** and **clear** physics investigation. Obtains, records, and displays data, using **appropriate** conventions and formats **mostly accurately and effectively.** **Logically** analyses and interprets data and evidence to formulate **suitable** conclusions with **reasonable** justification. **Logically** evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts. Develops and applies physics concepts **mostly** effectively in new **and** familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of physics **mostly coherently**, with **effective** use of appropriate terms, conventions, and representations.
C	Designs a **considered** and **generally clear** physics investigation. Obtains, records, and data, using **generally appropriate** conventions and formats with **some errors** but **generally accurately and effectively.** Undertakes **some** analysis and interpretation of data and evidence to formulate **generally appropriate** conclusions with **some** justification. Evaluates procedures and **some** of their effect on data.	Demonstrates knowledge and understanding of a general range of physics concepts. Develops and applies physics concepts **generally** effectively in new **or** familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of physics **generally effectively**, using **some** appropriate terms, conventions, and representations.
D	Prepares **the outline** of a physics investigation. Obtains, records, and displays data, using conventions and formats **inconsistently**, with **occasional** accuracy and effectiveness. **Describes** data and undertakes some **basic** interpretation to formulate a **basic** conclusion. **Attempts** to evaluate procedures or **suggest** an effect on data.	Demonstrates some basic knowledge and partial understanding of physics concepts. Develops and applies **some** physics concepts in **familiar** contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates **basic** physics information, using **some** appropriate terms, conventions, **and/or** representations.
E	**Identifies a simple** procedure for a physics investigation. **Attempts** to record and represent **some** data, with **limited** accuracy or effectiveness. **Attempts** to **describe** results **and/or** interpret data to formulate a **basic** conclusion. **Acknowledges** that procedures affect data.	Demonstrates limited recognition and awareness of physics concepts. **Attempts** to develop and apply physics concepts in **familiar** contexts. Attempts to explore and identify an aspect of the interaction between science and society. **Attempts** to communicate **information** about physics.

Task provided by Teacher:
Investigations Folio Task-
Part C: Time taken for a shape to fall through a liquid

Purpose of the investigation

To investigate the relationship between the time taken for a plasticine shape to fall through liquid and a property of the shape, such as its area of cross-section, shape or mass.

Description of assessment

Apparatus: Each group will have access to plasticene, a tall cylinder, water, 3 stopwatches, metre rulers, retort stands, measuring tape, an electronic balance, a knife and a white tile.

Your task:

Design

- In your group, discuss how you could test some of these properties in the laboratory. One double lesson will be available for supervised small group discussion and to do some planning.
- Individually, select one of the factors to test.
- Prepare the design for an appropriate investigation and include the following:
  - Introduction
  - aim and hypothesis
  - variables, factors that must be controlled, cannot be controlled
  - safety and other risks,
  - ethical considerations if applicable
  - list of materials
  - detailed procedure
  - suggest what the results would be if the hypothesis was supported
  - any limitations of the experiment or the conclusions that could be drawn, with justification
  - Use your physics knowledge to explain some of the issues or results
  - references for any research undertaken

One week will be provided to complete the written design. Internet and other sources of information may be used. Word count for this section, excluding the method, safety and or ethical considerations and references is approximately 250 words.

Due Date for design and feedback: _____

With your group, you will work together safely and collaboratively to undertake the investigation, collect data, and record your results.

Individually, you will use your results to write a report with the following:

- results (table and graph)
- discussion (analysis and evaluation)
- conclusion (justified and any limitations)

The design used must be attached to the report of your results.

The maximum word count for this section is approximately 1250 words, depending on the length of the first section. ***The combined maximum word count for both sections is 1500 words.***

Final Due Date: _____

Stage 2 Physics
Science as a Human Endeavour:
Great Inventions in Physics

The development of many inventions and techniques have been based on our understanding of physics concepts or resulted in the development of new scientific theories. There has always been a link between these inventions and techniques and society. You need to investigate **one** of the **contemporary** examples from the list below and prepare a report or presentation on the topic. Your report or presentation should **explain the physics concepts** involved, showing how it relates to at **least one key concept of science as a human endeavour. A list of these is on the next page.**

Electromagnetic devices:

Electrical transformers: cars, phone chargers, SA's power supply, arc-welders,

Induction stoves, induction coils in traffic sensors, electric cars, photocopiers, maglev trains, rollercoasters, railguns, radio, television, microwave ovens, mobile phones, defibrillators, generators.

Medical Diagnostic Devices/Techniques:

MRIs, X-Rays, Ultrasound, CAT Scans, PET scans, cyclotrons, Radiotherapy, Endoscopy, fluoroscopy.

Devices and Techniques using LASERS:

Industry (e.g. welding, engraving), medicine, eye surgery, tattoo removal, Blu-ray players, telecommunication.

Uses of Radionuclides:

Burglar alarms, medicine, industry, food production, nuclear power, nuclear waste, nuclear subs, nuclear weapons.

In this task you will:

- Access information from different sources and prepare a reference list
- Select relevant information about your investigation (invention/technique) to show that you understand both the relevant physics in the invention and its link to science as a human endeavour
- Analyse your findings to determine the lasting impacts of the invention on society.

Assessment Conditions:

This is an **individual** Investigation and you should submit one **draft** of your **introduction** by the end of the second week. (Due date: _____)

Your completed report should be submitted **electronically** within **4 weeks** in **any format** (e.g. a screencast, a video, an animation, a Web Page, a magazine article or report using MS Word, etc).

The maximum word count for the report is **1500 words.**

Your completed report should include the following:

- an introduction to identify the focus of the investigation and the key concept(s) of science as a human endeavour that it links to
- an explanation of how the focus of the investigation illustrates the interaction between science and society
- relevant physics concepts or background
- some appropriate diagrams to improve the effectiveness of your communication.
- a discussion of the potential impact or application of the invention/technique, e.g. further development, effect on quality of life, environmental implications, economic impact, intrinsic interest
- a conclusion with justification
- citations and referencing.

Science as a Human Endeavour in the study of physics encompasses:

Communication and Collaboration

- Science is a global enterprise that relies on clear communication, international conventions, and review and verification of results.
- International collaboration is often required in scientific investigation.

Development

- Development of complex scientific models and/or theories often requires a wide range of evidence from many sources and across disciplines.
- New technologies improve the efficiency of scientific procedures and data collection and analysis; this can reveal new evidence that may modify or replace models, theories, and processes.

Influence

- Advances in scientific understanding in one field can influence and be influenced by other areas of science, technology, engineering, and mathematics.
- The acceptance and use of scientific knowledge can be influenced by social, economic, cultural, and ethical considerations.

Application and Limitation

- Scientific knowledge, understanding, and inquiry can enable scientists to develop solutions, make discoveries, design action for sustainability, evaluate economic, social, and environmental impacts, offer valid explanations, and make reliable predictions.
- The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation.
- Science informs public debate and is in turn influenced by public debate; at times, there may be complex, unanticipated variables or insufficient data that may limit possible conclusions.

		A	B	C	D	E
Investigation, Analysis, and Evaluation	**3**	Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification.	Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification.	Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification.	Describes data and undertakes some basic interpretation to formulate a basic conclusion.	Attempts to describe results and/or interpret data to formulate a basic conclusion.
Knowledge and Application	**1**	Demonstrates a deep and broad knowledge and understanding of a range of physics concepts.	Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts.	Demonstrates knowledge and understanding of a general range of physics concepts.	Demonstrates some basic knowledge and partial understanding of physics concepts.	Demonstrates limited recognition and awareness of physics concepts.
	3	Critically explores and understands in depth the interaction between science and society.	Logically explores and understands in some depth the interaction between science and society.	Explores and understands aspects of the interaction between science and society.	Partially explores and recognises aspects of the interaction between science and society.	Attempts to explore and identify an aspect of the interaction between science and society.
	4	Communicates knowledge and understanding of physics coherently, with highly effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of physics mostly coherently, with effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of physics generally effectively, using some appropriate terms, conventions, and representations.	Communicates basic physics information, using some appropriate terms, conventions, and/or representations.	Attempts to communicate information about physics.

SACE Physics Program 2

This program articulates with learning and assessment plan 2

	Science Understanding	Science Inquiry Skills	Science as a Human Endeavour	Assessment
1-1	**1.1 Projectile Motion** Review of motion concepts • Vectors, scalars, significant figures • Terminology • Conditions for projectile motion • Equations of motion	• Projectile Launcher • Angle of projection and range relationship		
1-2	• Air resistance and drag force	• Dropping a ball bearing through a viscous liquid • Terminal velocity • Error analysis in experiments	• Swimming in syrup discussion • Factors affecting aerodynamics	**Investigations folio task 1: Design Experiment**
1-3	**1.2 Forces and Momentum** • Review of force concepts • Momentum and Newton's Second Law • Conservation of momentum and Newton's third law • Momentum using vectors	• Simple collisions (formative experiment)	• Using momentum to predict neutrinos	
1-4	• Momentum using multi-image diagrams • Applications of momentum • Rockets, solar sails	• Rocket demonstration • Air tracks	• Analysis of scenes from movies	
1-5	**1.3 Circular motion and gravitation** • Circular motion concepts • Applications (including banked curves) • Gravitational field strength • Law of Universal Gravitation • Satellites	• Centripetal force with glass tube and stopper (formative experiment)	• Black holes, dark matter, other celestial bodies	
1-6	• Kepler's Laws of planetary Motion • Satellites and their applications	• Predicting appearance of comets • Predicting the mass of stars and planets, using their natural satellites • Satellite tracking	• Hubble Space Telescope	
1-7	**Review / Catch up time**			**SAT1: (Subtopics1.1, 1.2, 1.3)**

	Science Understanding	Science Inquiry Skills	Science as a Human Endeavour	Assessment
1-8	**1.4 Einstein's relativity** • Frames of reference • Lorentz factor • Time dilation	• Evidence supporting time dilation	• Evidence for Einstein's postulates • Evidence against Einstein's postulates • Twin paradox	
1-9	• Length contraction • Relativistic momentum	• Relativity and GPS	• Difficulties obtaining evidence for length contraction	
1-10				*Formative Test on Subtopic 1.4*
Term 2				
2-1	**2.1 Electric Fields** • Review of concepts • Coulomb's Law • Vector addition and Coulomb's Law $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ • Representations of electric fields • Use of $\vec{E} = \vec{F}/q$ and $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ • Principle of superposition (electric fields)	• Use of application/detector to measure electric field strength and test relationship (formative experiment)	• Use and application of electric fields	
2-2	• Hollow conductors • Fields near sharp points • Corona discharge **2.2 Motion of charged particles in electric fields** • Work done and electric fields • Using $W = q\Delta V$ and $E = \Delta V/d$	• Corona discharges • van de Graaf generator • Different units of energy	• Strong electric fields • Particle accelerators	
2-3	• Acceleration of charged particles in electric fields • Use of equations of motion	• Teltron tube (formative experiment) • Comparison between Subtopic 1.1 and sub-topic 2.2	• Cathode ray tubes	

	Science Understanding	Science Inquiry Skills	Science as a Human Endeavour	Assessment
2-4	**2.3 Magnetic fields** • Representations of magnetic fields • Magnetic fields in current carrying wires • Use of $B = \frac{\mu_0 I}{2\pi r}$ **2.4 Motion of charged particles in magnetic fields** • Concept of magnetic force • Magnetic force acting on moving, charged particles • Use of $F = IlB\sin\theta$ and	• Use mobile application/detector to measure magnetic field strength to verify relationship (formative experiment) • Realistic values of magnetic field strength • Solenoids, electromagnets • Current balance (formative experiment)		**Investigations Folio: Charge to mass ratio of an electron**
2-5	• $F = qvB\sin\theta$ • Centripetal acceleration of charged particles at right angles to magnetic field • Use of $r = mv/qB$ • Function and operation of a cyclotron • Use of $T = 2\pi m/qB$ and $E_K = \frac{q^2B^2r}{2m}$	• Building a motor • Teltron tube • Charge to mass ratio of an electron (formative experiment)	• Loudspeakers • Motors • Generators • Magnetic fields in electron microscopes • Maglev trains	
2-6	**Review / Catch up time**			**SAT2: (sub-topics 2.1, 2.2, 2.3, 2.4)**
2-7	**2.5 Electromagnetic Induction** • Concept of magnetic flux • Electromagnetic induction • Faraday's Law and Lenz's law Solving problems using Faraday's law and Lenz's law	• Simulations	• Use and application of electromagnetic induction	
2-8	• Generators • Transformers • Solving problems with $\frac{V_p}{V_s} = \frac{n_p}{n_s}$	• Output of generators	• Transformers in everyday life • AC, DC, Edison and Tesla	*Formative Test on sub-topic 2.5*
2-9				**SAT3: SIS and extended response**

	Science Understanding	Science Inquiry Skills	Science as a Human Endeavour	Assessment
2-10	*Trial examinations*			*Formative trial exam*
Term 3				
3-1	**3.1 Wave behaviour of light** • Generation of electromagnetic radiation from oscillating charges • Use of antennas/polarisation • Coherent, monochromatic, and incandescent light sources • Constructive and destructive interference • Principle of superposition	• Polarisation paradox • Speckle effect	• Radio, WiFi, antenna • Data storage	**Investigations Folio: SHE task**
3-2	• Young's double slit experiment • Calculations, graphs, problem-solving • Use of $d\sin\theta = m\lambda$ and $\Delta y = \lambda L/d$.	• Lasers and double slit • Microwaves and double slit (formative experiment)		
3-3	• Transmission diffraction grating	• Use of white light on transmission diffraction grating (formative experiment) • Vapour lamps and spectra • Element identification	• Transmission diffraction gratings and disks	
3-4	**3.2 Wave-particle duality** • Photon model of light • Use of $E = hf$ and $p = h/\lambda$ Photoelectric effect	• Formative: photoelectric practical • Solar sails • Use of LEDs to measure Planck's constant (formative experiment)	• 'ultraviolet catastrophe' • Use and application of the photoelectric effect	
3-5	• X-rays • Generating –X-rays • Use of $f_{max} = e\Delta V/h$ • Wave behaviour of particles Davisson-Germer experiment	• Electron microscopes • X-rays in medicine	• Use and application of X-rays • Significance of Davisson-Germer experiment	
3-6	**3.3 The structure of the atom** • Line emission spectra • Energy level diagrams Line emission spectrum of hydrogen	• Flame tests • Spectroscopes • Simulations		

	Science Understanding	Science Inquiry Skills	Science as a Human Endeavour	Assessment
3-7	• Line absorption spectrum • Fraunhofer lines • Fluorescence • Incandescence • Population inversion, metastable states, stimulated emission lasers	• Analysis of solar spectra • Analysis of different absorption spectra • Laser safety	• Identification of elements in stars • Applications of lasers • Relationship between spectra and temperature	
3-8	**Review** **3.4 Standard Model** • Leptons, quarks, gauge bosons • Types and charge of quarks • Baryon, baryon numbers, lepton numbers • Antimatter and use of $E = \Delta mc^2$	• Use of quarks/antiquarks to form many different kinds of particles	• LHC and contemporary particle physics • Cyclotron at SAHMRI / PET scans	**SAT4: (Subtopics 3.1, 3.2, 3.3)**
3-9	• Conservation laws • Fundamental forces	• Use of conservation laws to predict reactions between particles	• Development of the Standard Model	
3-10	**Revision**			
Term 4				
1	**Revision**			
2	**Revision**			
3	**Revision**			

Stage 2 Physics

Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio **Weighting 30%**	**Design Experiment**: Students individually determine the area of physics they intend to investigate, then design an investigation, including the hypothesis, experimental method, data collection, identification and management of safety risks, and type of analysis appropriate to the method (as per Science Inquiry Skills). Students are assessed on their design of an investigation. Once the design has been assessed, students work in groups, select one of the designs to implement and undertake the investigation. Students record, represent, and analyse the data individually, evaluate procedures and consider their impact on results, formulate and justify a conclusion.	1,2,3,4	4	The total time allocated for supervision in class will be 70 minutes (30 minutes planning, 40 minutes collecting data). Students use homework time to complete the written report/multimodal product. The maximum report length is 1500 words, (excluding apparatus, method, results) or equivalent in multimodal form.
	Charge to mass ratio experiment: Students use a Teltron tube to determine the charge to mass ratio of an electron. Students take measurements (from photographs) using the scale on the Teltron tube to determine the radius of curvature of a beam of electrons deviated using Helmholtz Coils. These values are used to calculate the charge to mass ratio. Students analyse data (including error analysis) and evaluate procedures and consider their impact on results, formulate and justify a conclusion, taking into account the limitations of the investigation.	2,3,4	1,2,4	Students are allocated 80 minutes of supervised class time to collect data and begin the report. Students have homework time to complete the written report. The maximum report length is 1500 words, excluding apparatus, method, results.
	Science as a Human Endeavour Task: Students select at least one of the key concepts of science as a human endeavour to explore in the context of a contemporary example related to one of the topics in Stage 2 physics. The context is to be negotiated with the teacher as well as the medium of the presentation. Students complete a research planning document. They submit a report (article, website, video, oral presentation, etc.) with the structure identified in the subject outline.	1, 3	1,3,4	Students are allocated 80 minutes of supervised class time to decide on a SHE key concept (s), determine context and focus for the exploration, and begin research. Homework time is available. The maximum word length for scientific communication is 1500 words for written work, 10 minutes for an oral presentation, or the equivalent for a multimodal product.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 2: Skills and Applications Tasks Weighting 40%	**SAT1 – Motion** Students are assessed on Subtopics 1.1, 1.2, and 1.3. They demonstrate their knowledge of these topics through routine and analytical questions within the scope of the subject and in new and familiar contexts. Students' interpretive skills are assessed through a science inquiry skills question.	2,3	1,2,4	Written test, taken during supervised class time during an 80-minute double lesson. Students are provided with a formula sheet.
	SAT2 – Electricity and Magnetism Students demonstrate their knowledge through routine and analytical questions covering content from subtopics 2.1, 2.2, 2.3, and 2.4. There are questions in new experimental contexts and the test includes an extended response question.	3,4	1,2,4	Written test, taken during supervised class time during an 80-minute double lesson. Students are provided with a formula sheet.
	SAT3 – Short-answer, extended response, and experimental skills test Students are assessed on their answers to short and extended questions and complete experimental skills questions from any topic within the scope of the subject outline to this time.	2,3,4	1,2,4	Written test, taken during supervised class time during a 60-minute double lesson. Students are provided with a formula sheet.
	SAT4 – Light and Atoms. Students are assessed using routine and analytical questions based on subtopics 3.1, 3.2, and 3.3. Some questions are related to science as human endeavour, and the test includes an experimental skills question, using a context within the subtopics.	1,2,3	1,2,3	Written test, taken during supervised class time during an 80-minute double lesson. Students are provided with a formula sheet.
Assessment Type 3: Examination Weighting 30%	2-hour examination	Questions of different types cover all Stage 2 topics and science inquiry skills. Some questions may require students to integrate their knowledge from more than one topic and show an understanding of science as a human endeavour.		

Eight assessments. *Please refer to the draft Stage 2 Physics subject outline.*

Stage 2 Physics

Investigations Folio – Design Experiment

For this task you are required to design and undertake a physics experiment. This will be completed in three stages:

Planning: A physics context will be deconstructed and an experiment will be designed.

Experiment: The experiment that was designed will be undertaken.

Practical Report: The data will be recorded and analysed, and any conclusions will be discussed.

You may work in groups up to a maximum of three people, however each member needs to be submit their own plan and experiment report.

You can design an experiment in any area of physics provided that appropriate equipment is available.

You may wish to investigate one of the following:

- Factors that affect resistance to motion
- Damped motion of oscillating springs
- Factors that affect projectile motion
- Crater formation
- Measuring the thickness of hair or other small/thin objects
- Investigating different types of pendulum
- Investigate the properties of lasers

Your will be assessed according to the performance standards on the final page of this document based on following submissions:

Planning document: This document contains a planning section that needs to be completed. Each part has a series of guiding questions that you need to consider in preparing your experiment. Each member needs to submit their own document.

Due date: _____

Practical Report: Each member prepares and submits an individual practical report. Your practical report should include:

- Introduction with relevant physics concepts, a hypothesis and variables, or investigable question
- Materials/apparatus, method/procedure outlining any trials and steps to be taken*
- Identification and management of safety and/or ethical risks*
- Results*
- Analysis of results, identifying trends, and linking results to concepts
- Evaluation of procedures and data, and identifying sources of uncertainty
- Conclusion

The report should be a maximum of 1500 words, if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

*The four asterisked sections (materials/apparatus, method/procedure, ethical risks, and results) are excluded from the word count.

Due date: _____

Planning

You must complete the following two sections and be given approval before undertaking your experiment.

Context:

- What area of physics will you investigate?
- What physics understanding is required?
- What variables are involved?
- Which of these variables can be manipulated?

Lines inserted here for *Planning*

Deconstruction and Design:

- What outcomes are expected from manipulating different variables?
- Can you predict outcomes using your physics understanding?
- What hypothesis can you form using this context?
- What kind of experiment will test your hypothesis?
- What data will be collected?
- How will the data be analysed?
- How will the data be used to test your hypothesis?
- How will other variables be controlled?

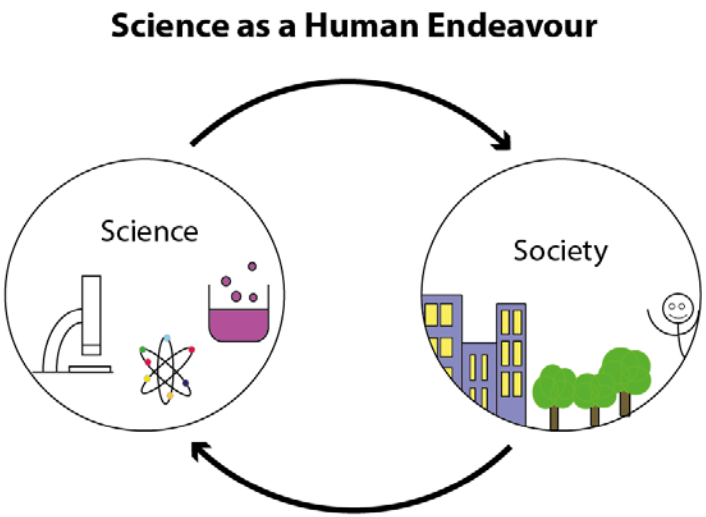
Lines inserted here for *Deconstruction and Design*

	Investigation, Analysis and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed physics investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of physics concepts. Develops and applies physics concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of physics coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear physics investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts. Develops and applies physics concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of physics mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear physics investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of physics concepts. Develops and applies physics concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of physics generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of a physics investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of physics concepts. Develops and applies some physics concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic physics information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a physics investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of physics concepts. Attempts to develop and apply physics concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about physics.

Stage 2 Physics
Science as a Human Endeavour Investigation

You are to investigate an aspect of physics with an emphasis on science as a human endeavour (SHE).

Your topic must be related to at least one aspect of the Stage 2 Curriculum.



Some aspects of Science as a Human Endeavour from the curriculum statement given below, however, you are encouraged to formulate your own questions or areas of exploration.

- Explore examples of the way that scientists have been able to develop solutions affecting aerodynamics (such as shape, texture, and spin).
- Explore perspectives in the public debate about the economics of space exploration
- Research spacecraft propulsion systems, considering technical challenges and speculative technology
- Explore how scientists use the gravitational force to indirectly detect the existence of stars, planets. Moons, black holes, and other celestial bodies, and to predict the existence of dark matter
- Explore how new evidence led scientists to modify models to account for high speed particles that exhibited properties that were inconsistent with Newtonian physics
- Assess the benefits and limitations of applications of electrostatic shielding
- Evaluate the economic, social, or environmental impacts of some applications of charges moving within magnetic fields
- Explore the need for cyclotrons and nuclear reactors in the production of radioisotopes, including the role of public debate

- Explore examples of new technologies enabled by an understanding of electromagnetic waves
- Explore emerging technologies which use optical data storage
- Explore innovations that use the photoelectric effect
- Explore how the wave nature of electrons has led to a diverse range of contemporary applications.
- Explore that ways that lasers have been utilised to measure quantities, solve problems and store and transmit data.
- Explore how data from the Large Hadron Collider is collected and analysed

You are to access information from different sources, select relevant information, analyse your findings, and develop and explain your own conclusions from the investigation.

Possible starting points for investigation could include:

- an article from a scientific journal (e.g. Cosmos)
- critiquing a blog or TED talk based on a physics concept
- an advertisement or a film clip in which a physics concept is misconstrued
- scientifically analysing a game
- an expert's point of view
- a new development in the field of physics endeavour
- the impact of a technique and its historical development
- concern about issue which has environmental, social, economic, or political implications
- emerging physics-related careers
- changes in government funding for physics-related purposes, e.g. for scientific research into decommissioned satellites and spent rocket stages, various forms of medical imaging, quantum computers and extremely high data transfer, ring laser guidance systems and their application for accurate aircraft navigation, use of nuclear isotopes for industrial or medical applications, monitoring changes in global temperature.

The report on your science as a human endeavour investigation should be a maximum of 1500 words if written or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form. You be assessed on according to the performance standards given below.

The scientific report must include the use of scientific terminology and:

- an introduction to identify the focus of the investigation and the key concept(s) of science as a human endeavour that it links to
- an explanation of how the focus of the investigation illustrates the interaction between science and society
- relevant physics concepts or background
- a discussion of the potential impact or application of the focus of the investigation, e.g. further development, effect on quality of life, environmental implications, economic impact, intrinsic interest
- a conclusion with justification
- citations and referencing.

The key concepts of *Science as a Human Endeavour* are:

Communication and Collaboration

- Science is a global enterprise that relies on clear communication, international conventions, and review and verification of results.
- International collaboration is often required in scientific investigation.

Development

- Development of complex scientific models and/or theories often requires a wide range of evidence from many sources and across disciplines.
- New technologies improve the efficiency of scientific procedures and data collection and analysis; this can reveal new evidence that may modify or replace models, theories, and processes.

Influence

- Advances in scientific understanding in one field can influence and be influenced by other areas of science, technology, engineering, and mathematics.
- The acceptance and use of scientific knowledge can be influenced by social, economic, cultural, and ethical considerations.

Application and Limitation

- Scientific knowledge, understanding, and inquiry can enable scientists to develop solutions, make discoveries, design action for sustainability, evaluate economic, social, and environmental impacts, offer valid explanations, and make reliable predictions.
- The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation.
- Science informs public debate and is in turn influenced by public debate; at times, there may be complex, unanticipated variables or insufficient data that may limit possible conclusions.

Performance Standards for Stage 2 Physics

	Investigation, Analysis and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed physics investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and their effect on data.	Demonstrates deep and broad knowledge and understanding of a range of physics concepts. Develops and applies physics concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of physics coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear physics investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effect on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts. Develops and applies physics concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of physics mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear physics investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effect on data.	Demonstrates knowledge and understanding of a general range of physics concepts. Develops and applies physics concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of physics generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of a physics investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of physics concepts. Develops and applies some physics concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic physics information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a physics investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of physics concepts. Attempts to develop and apply physics concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about physics.

Science Enquiry Skills and Extended Response

PHYSICS

insert date

Summative Test Material: One question booklet with formula sheet

Approved dictionaries and calculators may be used

Instructions to students

1. You will have 5 minutes to read the paper. You must not write in your question booklets or use a calculator during this reading time but you may make notes on the scribbling paper provided.
2. The allocation of marks are given below each question, however, your final grade is determined by the performance standards given. The total number of marks and time allowed is given as:

Total 38 marks - 40 minutes

4. The equation sheet is provided for use during the test.
5. Marks may be deducted if you do not clearly show all steps in the solution of problems or if you do not define additional symbols. You should use diagrams where appropriate in your answers.
6. Use only black or blue pens for all work other than graphs and diagrams, for which you may use a sharp dark pencil.

	Investigation, Analysis and Evaluation	Knowledge and Application
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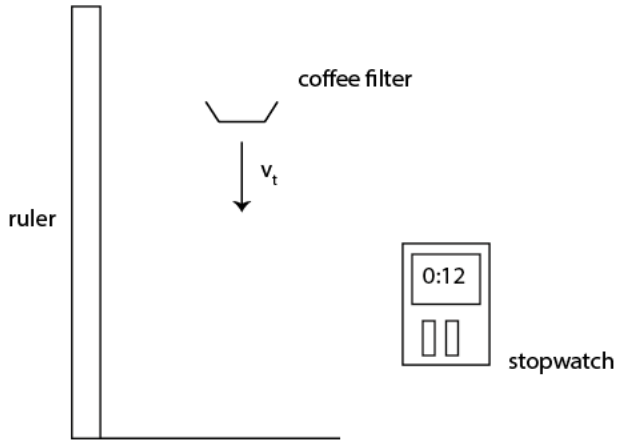
1. A student undertook an experiment to determine the drag coefficient of a paper coffee filter. The filter was dropped from a fixed height, and its terminal speed, v_t, was determined using a stopwatch. The mass was then altered by adding small pieces of plasticine, and the terminal speed recorded again. The experiment was repeated three times.



(a) Explain which is the dependent variable in this experiment.

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_____(2 marks)

Their results are shown in the table below:

Mass (g)	Trial 1 v_t (ms^{-1})	Trial 2 v_t (ms^{-1})	Trial 3 v_t (ms^{-1})	Average v_t (ms^{-1})
0.95	0.85	0.89	0.86	0.87
1.90	1.25	1.30	1.28	1.28
2.83	1.50	1.56	1.54	1.53
3.79	1.78	1.80	1.73	1.77
4.74	1.90	1.95	1.85	1.90

(b) Explain why repeating an experiment increases accuracy.

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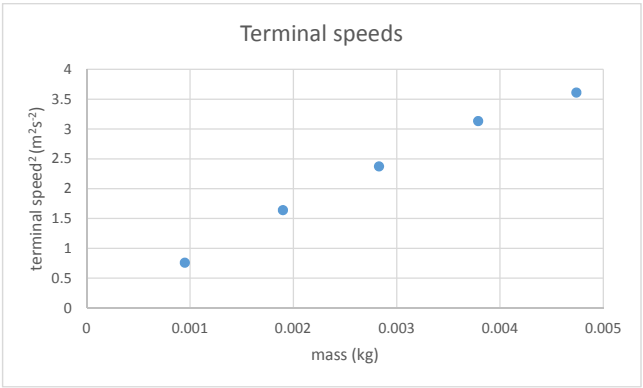
_____(2 marks)

The student then graphed v_t^2 against m.



(c) Sketch a line of best fit on the graph above. Calculate its gradient.

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_____(3 marks)

(d) Explain if there is any evidence of systematic errors on the graph above.

_____

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_____(2 marks)

The terminal speed of an object is given by:

$$v^2 = \frac{2mg}{C_d A \rho}$$

Where m is the mass, g is the acceleration due to gravity, C_d is the drag coefficient and ρ is the density of the medium.

In this experiment, the acceleration due to gravity is 9.81 ms^{-2}, the cross sectional area was 0.0175m^2 and the density of air is 1.225 kgm^{-3}.

(e) Determine the drag coefficient of the coffee filter.

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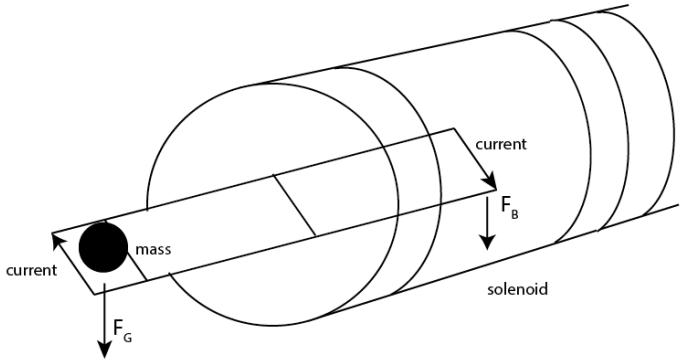
_____(2 marks)

2. Two students are attempting to determine the magnetic field strength around a solenoid using a current balance apparatus. As a current flows through the balance, a force due to the magnetic field, F_B, pushes the balance inside the solenoid downwards.

   At the open end of the solenoid, the balance is pushed upwards. This is balanced by the force due to gravity, F_G, as mass is added to the balance at the open end.

   When the balance is level, $F_G = F_B$. The students manipulate the current through the balance and record the mass required to balance.



(a) State and explain whether the current through the solenoid is flowing clockwise or anticlockwise.

_____

_____

_____

_____(2 marks)

Two students, Marayam and Timothy obtain the following results

Marayam

Current (A)	Mass (g)
0.02	0.011
0.04	0.023
0.06	0.032
0.08	0.041
0.10	0.053

Timothy

Current (A)	Mass (g)
0.015	0.0168
0.042	0.0471
0.055	0.0617
0.083	0.0932
0.14	0.157

(b) Explain which of the two students has the more precise data.

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_____(2 marks)

(c) Show that the current balance is level when the mass is given by $m = \frac{BI\Delta l}{g}$, where B is the magnetic field strength of the solenoid, I is the current through the current balance, g is the acceleration due to gravity and Δl is the width of the current balance.

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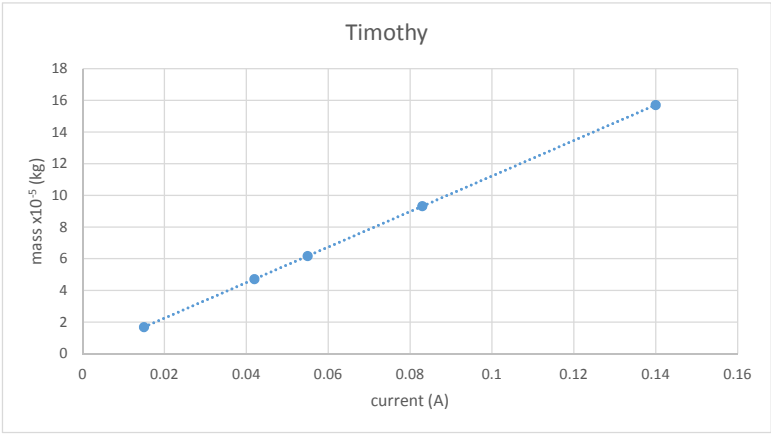
_____(3 marks)

Timothy's results are displayed in the graph below:



(d) Calculate the gradient of the line of best fit.

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_____(3 marks)

(e) Use your answer to (d) to calculate the magnetic field strength of the solenoid. The width of the current balance is 0.025 m and the acceleration due to gravity is 9.81 ms^{-2}.

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_____(3 marks)

Marayam found that her results gave the magnetic field strength of the solenoid as 0.20 T.

A electronic device used to measure the magnetic field strength directly gave a value of 0.28T.

(f) Explain which student had the more accurate data.

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_____(2 marks)

3. Cyclotrons are used to produce radioisotopes that are used for medical applications. The South Australian Health and Medical Research Institute (SAHMRI) has a cyclotron which produces radioisotopes for use in identifying and treating cancer.

- Describe the nature and direction the magnetic field needed to deflect ions into a circular path into the dees of a cyclotron
- Discuss the importance of being able to generate radioisotopes in Adelaide instead of having radioisotopes transported from interstate.

(12 marks)

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Stage 2 Physics – Video games and Technology Program – Full Year

This is a 20-credit program for students intending to study Stage 2 Physics.

The number of lessons is equivalent to approximately 120 hours over 2 semesters, including 16 – 20 hours of practical activities.

The program covers:
Topic 1: Motion and Relativity **Topic 2**: Electricity and Magnetism **Topic 3**: Light and Atoms

The Physics of video games and computer simulations (Topic 1: Motion and Relativity) Computer game developers program physics equations in to their game engines, which are used in the development of video games. This provides players with a realistic and unique gaming experience, and a potentially reduced cost to develop. They are one of the key selling points of modern games.		
Weeks 1 – 3: The Physics equations used to move projectiles in computer games (Subtopic 1.1: Projectile Motion)		
Science Understanding	Activities/teaching strategies	Tasks
• Constant Acceleration equations • Projectile motion (horizontal and vertical component analysis) • Projectile motion calculations (time of flight, range, trigonometry with velocity) • Projectile motion explanations (Maximum range, launch height, launch speed and launch angle relationships) • Air resistance and terminal velocity	• Use http://www.opensourcephysics.org/items/detail.cfm?ID=12169 to illustrate the constant horizontal velocity component and the constant vertical acceleration component • Use http://www.opensourcephysics.org/items/detail.cfm?ID=9998 to practice resolving vectors into components • Use the "*Tracker*" physics program to analysis projectile motion in games such as "Angry Birds" for realism. http://www.opensourcephysics.org/items/detail.cfm?ID=11562 (SIS) • Use *Scorched 3D* (open source video game) to illustrate the effect of changing the lunch angle and initial velocity on the range. http://www.scorched3d.co.uk/ • Use https://phet.colorado.edu/en/simulation/projectile-motion to investigate effects of Air resistance. (SIS) • Research how computer wind tunnel simulations have influenced areas of society. (SHE, I*) • Projectile Motion Worksheet.	***Formative SIS***: Use a camera to video the motion of an object, with a large drag coefficient, thrown at an angle. Use *Tracker* to analysis the motion of the object and obtain a set of equations that would be used to simulate the same motion in a computer game. (2 pages or less)
Week 4: The Physics equations governing collisions in computer games (Subtopic 1.2: Forces and Momentum)		
• Momentum definition and conservation from stage 1 • Momentum in 2-Dimensions • Newton's Second Law in terms of force • Newton's Third Law and conservation of momentum • Momentum and Space	• Use linear air track to revise 1-Dimensional momentum from Stage 1 Physics. (SIS) • Use https://phet.colorado.edu/en/simulation/collision-lab for 2-Dimensional momentum, conservation of momentum. • Introduce the concept of how a spacecraft moves in space by demonstrating the space simulator Orbiter 2016 http://orbit.medphys.ucl.ac.uk/ (Simulation scenarios: "Solar Sail" and "Atlantis in orbit") • Research how computer simulations and being used in the preparation for space exploration. (SHE, A&L*) • Momentum and forces Worksheet.	
Weeks 5 – 7: The Physics equations used in space simulators (Subtopic 1.3: Circular Motion and Gravitation)		
• Uniform Circular Motion (acceleration + direction, period, speed, Force) • UCM and Banked Curves • Newton's Law of Universal Gravitation • Gravitational Field strength (*g*) • Satellites and circular orbits • Kepler's Laws of Planetary Motion • Types of Orbits	• Use a rubber stopper on the end of a sting and a mass carrier to investigate the centripetal motion http://physics.bu.edu/~duffy/sc525_notes08/centripetal.pdf (SIS) • Use http://www.mhhe.com/physsci/physical/giambattista/banked_curve/banked_curve.html to demonstrate the physics of Banked Curves. More information http://www.lajpe.org/jan10/06_Vasudeva_Rao.pdf • Explain how banking roads increase safety (SHE, I*) • Use https://phet.colorado.edu/en/simulation/gravity-force-lab to teach Newton's Law of Universal Gravitation • Define gravitational field strength and calculate for the surface of Earth. Use *Tracker* to analyse the motion of an object dropped from a height, to connect the concept with everyday experience. (SIS) • Use Newton's Mountain Model http://www.compadre.org/osp/items/detail.cfm?ID=9391 to discuss Newton's	***Summative SAT 1***: Analyse a number of videos that display the motion of objects in different contexts, from subtopics 1.1 to 1.3. ***Formative SHE***: Research how

	explanation of an orbiting body being essentially projectile motion at high speed. • Use https://phet.colorado.edu/en/simulation/legacy/my-solar-system to demonstrate elliptical orbits and Kepler's laws • Use https://phet.colorado.edu/en/simulation/legacy/gravity-and-orbits to demonstrate motion of objects in circular orbit • Students undertake a simulation scenario on the space simulator Orbiter 2016 (http://orbit.medphys.ucl.ac.uk/) of their choice, to give them understanding of motion in space. • Circular motion and gravitation worksheet	countries have collaborated in order to make the International Space Station (ISS) possible and functioning, particularly in terms of computer software. Also investigate one experiment that has been performed on the ISS and its impact on current scientific understanding. (SHE, C&C, D, A&L) (500 words or less)
Weeks 8 – 9: What does relativity, GPS satellites and Pokémon Go have in common? (Subtopic 1.4: Einstein's Relativity)		
Science Understanding	Activities/teaching strategies	Tasks
• Inertial reference frames • Postulates of Special Relativity • Time dilation and subatomic particles • Length contraction • Relativistic Mass and momentum	• Watch the 1960s educational video about frames of reference https://www.youtube.com/watch?v=aRDOqiqBUQY • Use *Tracker* to analysis a video of a ball thrown up vertically while the camera is moving with a constant speed horizontally and show the similarities with projectile motion. (alternatively watch http://www.flippingphysics.com/skateboarding.html) (SIS) • Use Real Time Relativity Simulation (http://people.physics.anu.edu.au/~cms130/vrproject/teachingpackage.html) with lab manual (http://people.physics.anu.edu.au/~cms130/vrproject/resources/Labman_s2_2008_RTR_web.doc) to teach special relativity. (SIS) • Explain how the acceptance of special relativity relied on evidence from many experiments (SHE, C&C, D*) • Investigate why GPS satellites need to use special relativity to work accurately. (SHE, C&C*) • Special Relativity worksheet (including SHE)	

The technology that drives video games and simulations (Topic 2: Electricity and Magnetism)

A combination of simple electronic components is connected together to form complex computer hardware. A critical number of computer hardware are connected together to form platforms that video games can be played on.

Week 10 – 11: Capacitors; solid state fans, electrostatic loudspeakers and laser printers: Electric fields in action (Subtopic 2.1 Electric Fields)		
Science Understanding	Activities/teaching strategies	Tasks
• Electric Force Between two charges: Coulombs Law • Superposition of Electric Forces • Electric Field Definitions • Sketching Electric fields for point charges, two point charges, finite parallel plates, hollow spherical conductors, pear-shaped conductors. • Corona Discharge	• Use http://www.physicsclassroom.com/Physics-Interactives/Static-Electricity/Coulomb-s-Law/Coulomb-s-Law-Interactive to test Coulomb's Law. • Use electric field apparatus, oil and seeds to demonstrate the electric field for point charges, two point charges, and finite parallel plates. Students sketch the fields. (SIS) • Use https://phet.colorado.edu/en/simulation/charges-and-fields to demonstrate electric field strengths of a single charge and two point charges. • Use Van de Graaff Generator to explain the action of a corona discharge is. (SIS) • Explain how capacitors, solid state fans, electrostatic loudspeakers and laser printers work. (SHE, A&L*) • Electric fields worksheet	***Summative Practical Investigation 1 (SIS)***: Explore Coulomb's Law between two Styrofoam balls covered in aluminium foil, as the charge on them increases.
Week 12 – 13: Why electrons flow (Subtopic 2.2 Motion of Charged Particles in Electric Fields)		
• Electric potential energy (and difference)	• Use http://www.wiley.com/college/halliday/0470469080/simulations/sim16/sim16.html and Electric Field Hockey game (https://phet.colorado.edu/en/simulation/legacy/electric-hockey) to explain the concept of charges moving in electric fields. • Use cathode ray tube or Teltron Tube to demonstrate the deflection of electrons between parallel plates. (SIS) • Use http://www.wiley.com/college/halliday/0470469080/simulations/sim16/sim16.html to explain the motion of charges at an angle to a uniform field. • Motion of charges in Electric fields worksheet (including SIS)	
• Work done on charges • Electron volt unit • Electric field between two parallel plates. • Motions of charges parallel or anti-parallel to uniform electric fields • Motion of charges in cyclotrons • Motion of charges at angle to a uniform electric field (Projectile motion similarity)		
Week 14 - 15: The solenoid, magnetic storage devices and the moving coil loud speaker (Subtopic 2.3 Magnetic Fields)		
• Magnetic Fields defined • Sketch the magnetic fields of a current in a straight wire, loop, and solenoid • Biot-Savart Law for a current in a straight wire.	• Use Magnetic field apparatus and iron filings to demonstrate the magnetic field for straight wire, loop, and solenoid. Students sketch the fields. (SIS) • Explain how a moving coil loud speaker works, how a magnetic hard disk stores information, how solenoids work and used in computers. (SHE, A&L*) • Explain the Biot-Savart Law for a current in a straight wire. • Magnetic fields questions (including SIS)	***Formative SIS***: Use a solenoid and current balance to investigate the relationship between magnetic field strength and current with a wire. (2 pages or less)
Week 16 – 17: How a magnetic field is used in computers (Subtopic 2.4 Motion of Charged Particles in Magnetic Fields)		
Science Understanding	Activities/teaching strategies	Tasks
• Magnetic force on charges and current carrying wires (Direction + magnitude) • Motion of charges at right angles to a uniform magnetic field (UCM similarity) • Radioisotope formation in cyclotrons • Magnetic Fields in cyclotrons	• Use cathode ray tube or Teltron Tube with Helmholtz coils to demonstrate the deflection of electrons in magnetic fields. (SIS) • Use http://www.wiley.com/college/halliday/0470469080/simulations/sim16/sim16.html to explain the concept to charges moving in magnetic fields. • Use the cyclotron applet at http://www.kcvs.ca/site/projects/physics.html to explain the motion of different charges in a cyclotron. • Investigate the uses of medical radioisotopes and their limitations (SHE, I, A&L*) • Discuss the road map to having different medical imaging techniques available in Adelaide and the importance of the cyclotron at the SAMHRI facility. (SHE, I, A&L) • Motion of charges in Magnetic fields activity sheet (including SIS)	***Summative SAT 2***: A range of questions assessing Scientific Inquiry Skills, from subtopics 1.4 to 2.4.
Week 18 – 20: How power is supplied to video game platforms (Subtopic 2.5 Electromagnetic Induction)		
Science Understanding	Activities/teaching strategies	Tasks
• Magnetic Flux definition • Electromagnetic induction and electromotive force • Faraday's Law and Lenz's Law • How Generators work and their uses • How Transformers work and their uses	• Define the magnetic flux • Use the "Faraday's Law" applet from https://phet.colorado.edu/en/simulations/category/physics to help explain Faraday's Law • Use "Faraday's Electromagnetic Lab" To explain and explore How Generators and Transformers work. (https://phet.colorado.edu/en/simulations/category/physics) (SIS) • Explore the uses and positive and negative impact of eddy currents. (SHE, A&L*) • Explain how transformers are used in computer power supplies (SHE, A&L*) • Explain how data is read from a magnetic computer hard drive. (SHE, A&L*) • Research the economic, social and environmental impacts of different forms of power generation. (SHE, A&L*) • EM Induction questions	***Summative SAT 3***: Prepare a feasibility statement on a complex problem, from subtopics 2.5.

More of the technology that drives video games and possible future improvements (Topic 3: Light and Atoms)

Substantial future gains in computer processing power could be possible from the integration of current and future understanding of the behaviour of light and atoms.

Week 21- 22: Wireless transmission of Information and CD/DVDs/Blue-rays (Sub-topic 3.1: Wave Behaviour of Light)

Science Understanding	Activities/teaching strategies	Tasks
• Production of EM Waves • What are EM Waves • Use of EM Waves in the transmission of information • Definitions of Monochromatic light and coherent wave sources • Interference of waves from two monochromatic, coherent sources • Young's double slit experiment • Interference pattern from a transmission diffraction grating.	• Use https://phet.colorado.edu/en.simulation/legacy/radio-waves to explain how EM Waves are produced by and received antennas • Define monochromatic light and also coherent wave sources • Use https://phet.colorado.edu/en/simulation/legacy/wave-interference to explain wave interference • Research some of the wireless communication technologies and specifically international collaboration of standards (SHE, C&C*) • Explain Young's double slit experiment and its impact on the development of what light is. (SHE, C&C, D*) • Use a laser, different diffraction gratings and ruler to in investigate the interference pattern of a transmission diffraction grating. Use the results to measure the wavelength of the laser. (SIS) • Explain how information is read from a CD/DVDs/Blue Rays using the interference of light. (SHE, A&L*) • Wave Behaviour of Light activities (including SIS)	***Formative SHE***: Research some of the limitations of wireless communications over wired and explain the some of the reasoning for the choice of the NBN in Australia (SHE, I, A&L) (500 words or less)

Week 23 – 25: Photodiodes, Semiconductor Transistors, Quantum computers (Sub-topic 3.2: Wave-Particle Duality)

Science Understanding	Activities/teaching strategies	Tasks
• Light as particles • Photoelectric experiment • X-Ray production • X-Ray's interaction with matter • Wave behaviour of particles (de Broglie wavelength • Davisson-Germer experiment	• Use https://phet.colorado.edu/en/simulation/legacy/quantum-wave-interference to help explain interference of light at very low intensities hence light behaving as a particle. • Use https://phet.colorado.edu/en/simulation/legacy/photoelectric to explain the photoelectric effect. • Research the historical development of the model of light and how Einstein used the photoelectric effect to contribute to it. (SHE, C&C, D*) • Use a photoelectric unit to conduct an experiment into the changing of the frequency of incident light and the maximum kinetic energy of electrons. (SIS) • Explain the applications of the photoelectric effect in relation to electrostatic levitation and night vision devices. Also, how the photoelectric effect can help explain Moon dust streams away from the lunar surface. • Students use tutorials on X-rays at http://www.radiologymasterclass.co.uk/tutorials/physics/x-ray_physics_introduction. • Use https://phet.colorado.edu/en/simulation/legacy/quantum-wave-interference to help explain then electrons and other particles behaving as waves. • Use https://phet.colorado.edu/en/simulation/legacy/davisson-germer to help explain the Davisson-Germer experiment • Explain the physics behind Quantum computers (wave-particle duality) in broad terms focusing also on its development and international collaboration. (SHE, C&C, D*) • Wave-Particle Duality worksheet (including SIS)	***Summative Practical Investigation 2 (SIS)***: Explore an aspect of the effectiveness of a photodiode.

Week 26 – 28: Atomic structures through computer software and application of Lasers. (Sub-topic 3.3: Structure of the Atom)

Science Understanding	Activities/teaching strategies	Tasks
• Blackbody radiation • Atomic energy levels and line emission	• Use https://phet.colorado.edu/en/simulation/legacy/blackbody-spectrum to explain blackbody radiation. • As revision, use https://phet.colorado.edu/en/simulation/build-an-atom to build an atom.	***Summative SHE***: Explore a recent or near future development in computer
spectra • Line emission spectrum of atomic hydrogen • Ionisation • Line absorption spectrum • Fluorescence • Stimulated emission, meta stable states, population inversion • How a laser works	• Use the "Bohr" model in "predictions" https://phet.colorado.edu/en/simulation/legacy/hydrogen-atom to help explain the atomic energy levels of hydrogen. Use the "experiment" to show the build-up of the line emission spectrum for hydrogen. • Use https://www.edumedia-sciences.com/en/media/536-energy-level-diagram to explain energy level diagrams, ionisation, and fluorescence. • Use the application "SpectraSnapp" on an iOS device (or a spectrum analyser for android or windows devices) and a diffraction grating to explore atomic spectra of chemical compounds. (flame test of old) (SIS) • Use https://www.edumedia-sciences.com/en/media/661-emission-and-absorption-spectra to explain Line absorption spectrum • Explore how line absorption spectra can be used to make discoveries and reliable predictions about the composition and motion of stars. (SHE, I, A&L*) • Explain Stimulated emission, meta stable states, population inversion and Use https://phet.colorado.edu/en/simulation/legacy/lasers to explain how lasers work. (SHE, A&L*) • Structure of an Atom activity sheet (SIS)	hardware or equipment that has the potential to change how we use electronic devices and impact society and present a scientific report showing the interaction between science and society.

Week 29 – 30: How computers are used to investigate sub-atomic structures. (Subtopic 3.4: Standard Model)

Science Understanding	Activities/teaching strategies	Tasks
• The three fundamental particles: Leptons, Quarks, and Gauge bosons • Gauge bosons and the four fundamental forces • Types of Quarks • Conservation laws in particle reactions • *Feynman diagrams* (*Extension activity only*) • Antimatter and annihilation events.	• Explain how everything is made out of the three fundamental particles. • Explain the four fundamental forces in terms of particle exchanges • Use Lego to explain quarks, and the formation of hadrons, and the weak force, and Feynman diagrams (http://ph.qmul.ac.uk/engagement/physics-kits) • Students explore the Virtual Atom Smasher at http://test4theory.cern.ch/about/ (SIS) • Explain antimatter annihilation and the development of, and the increase access to PET scanners. (SHE, D, I, A&L*) • Research the development of particle accelerators and how they have contributed to our understanding of the subatomic world. (SHE, C&C, D, I*) • Use experimental data from particle accelerators or a cloud chamber to interpret data from particle accelerators and how that relates to discoveries in physics. (SIS) • Explain how particle reactions obey conservation laws • *Draw Feynman diagrams of the electromagnetic force between two electrons, the weak nuclear force during beta decay, the strong nuclear force between a proton and a neutron. (Extension activity only)* • Standard Model questions (SIS)	***Summative SAT 4:*** complete a range of questions from subtopics 2.1 to 3.4.

Week 31 - 33: Trial Exam and Exam Revision

*The following abbreviations are used to indicate which of the key concepts of science as a human endeavour will be the focus of development:

- C&C = Communication and Collaboration
- D = Development
- I = Influence
- A&L = Application and Limitation

Stage 2 Physics
Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of all of the assessment design criteria.

Assessment Type and Weighting	Details of assessment	Assessment Design Criteria		Assessment conditions (e.g. task type, word length, time allocated, supervision)
		IAE	KA	
Assessment Type 1: Investigations Folio **Weighting 30%**	**Practical Investigation 1 (Coulombs Law):** Students investigate the electrostatic force between two polystyrene balls wrapped in aluminium foil as the charge on them is changed. They state a hypothesis and identify variables and safety aspects in a provided procedure and use the procedure to manipulate apparatus using safe and ethical work practices. They collaborate to collect and represent the data, then individually interpret and analyse it using appropriate technology, linking results to concepts. Students use graphical analysis of the data to assist in their interpretation. They evaluate the procedure through considering errors, identifying sources of uncertainty, and suggesting improvements to the procedure and present and justify a conclusion relevant to the hypothesis. They submit an individual practical report.	2, 3, 4	1, 4	Students are supervised and have 45 minutes to read through practical and submit the hypothesis, discussion of variables, hazards and safety and their results table design. Can be electronically word processed. Students are supervised and have a further 90 minutes to perform the practical. Students then have homework time to complete the written report, which is a maximum length of 1500 words (excluding apparatus, method and results).
	Practical Investigation 2 (Design Investigation): Students explore one aspect of the effectiveness of a photo-diode/photo-transistor in the context of an application of their choice. They design and conduct their own practical investigation. They state a hypothesis, identify variables and safety aspects and management, and provide the procedure. They carry out the procedure, manipulating apparatus using safe and ethical work practices. Students collect, represent, interpret, and analyse data using appropriate technology, linking results to concepts. They use graphical analysis of the data to assist in their interpretation. They evaluate the procedure through considering errors, identifying sources of uncertainty, and suggesting improvements to the procedure and present and justify a conclusion relevant to the hypothesis. They submit an individual practical report.	1, 2, 3, 4	1, 4	Students have one week to submit the design of the investigation, electronically word processed. Students are supervised and have 90 minutes to perform their practical. Students then have homework time to complete the written report, which is a maximum length of 1500 words (excluding apparatus, method and results).
	SHE (Future Computer Technology): Students explore and present a scientific report about a recent or near future development in computer hardware or equipment that has the potential to change how we use electronic devices. They select the technology based on it being an application from the science understanding statements in the subject outline. Students explain how the hardware (or the development of it) illustrates the interaction between science and society, referring to at least one of the key concepts of science as a human endeavour described in the subject outline. They analyse, and interpret information related to the topic to formulate and justify conclusions. Students cite and list references correctly. They summarise and explain the physics relevant to the topic, and identify its impact on society. Students communicate their findings in either an ICT presentation or a written report.	3	1, 2, 3, 4	Students have 90 minutes of supervised class time to decide on a topic and a SHE aspect and start researching. They have 3 weeks of unsupervised time to complete the scientific communication. The maximum word count is 1500 words for written work, 10 minutes for an oral presentation, or the equivalent for a multimodal product.
Assessment	**SAT 1 (Motion Videos)**: Students demonstrate knowledge and understanding of the Science	2, 3	1, 2, 4	Electronically word processed – supervised – 90
Type 2: Skills and Applications Tasks **Weighting 40%**	Understanding statements, form the subject outline, covered in the subtopics 1.1 to 1.3. They apply this knowledge by using a computer program to analyse a range of motion videos and answering questions, using correct terminology, formulae and equations. Students analyse problems and pose solutions using appropriate physics terms and conventions. Questions vary from routine to complex and include new and familiar contexts.			minutes Students will have access to a formula sheet.
	SAT 2 (Science Inquiry Skills): Students demonstrate knowledge and understanding of the Science Understanding statements, from the subject outline, covered in the subtopics 1.4 to 2.4 and the science inquiry skills. They apply this knowledge by answering questions, using correct terminology, formulae and equations. Students design investigation, analyse problems, and pose solutions using appropriate physics terms and conventions. Questions vary from routine to complex and include new and familiar contexts.	1, 2, 3, 4	1, 2, 4	Partly electronically word processed partly hand written – supervised – 90 minutes Students will have access to a formula sheet.
	SAT 3 (Feasibility Statement): Students demonstrate knowledge and understanding of the Science Understanding statements, form the subject outline, covered in the subtopics 1.5 and Science as a Human Endeavour. They apply this knowledge by analysing a complex situation and writing a feasibility statement on it, using correct terminology, formulae and equations. Students use appropriate physics terms and conventions in writing the statement. They then present their feasibility statements orally and/or with an electronic slide show.		1, 2, 3, 4	(Either electronically word processed or hand written) and presented orally – supervised – 55 minutes Students will have access to a formula sheet.
	SAT 4: Students demonstrate knowledge and understanding of the Science Understanding statements, from the subject outline, covered in the subtopics 2.1 to 3.4. They apply this knowledge by answering questions, using correct terminology, formulae and equations. Students analyse problems and pose solutions using appropriate physics terms and conventions. Questions vary from routine to complex and include new and familiar contexts.		1, 2, 4	Hand written– supervised – 90 minutes Students will have access to a formula sheet.
Assessment Type 3: Examination **Weighting 30%**	2-hour examination	All specific features of the assessment design criteria for this subject may be assessed in the external examination. Questions of different types cover all Stage 2 topics and science inquiry skills. Some questions may require students to integrate their knowledge from more than one topic and show an understanding of science as a human endeavour.		

Eight assessments. *Please refer to the Stage 2 Physics subject outline.*

Science as a Human Endeavour Investigation

Summary of Task

Your task is to explore a recent or near future development in computer hardware or equipment that has the potential to change how we use electronic devices. (e.g. wireless changing, quantum computers, biometric sensors, projection keyboards etc.) and present a scientific report about it.

The hardware that is the focus ***needs*** to be a direct application of physics concepts from Stage 2 Physics. You will show how it demonstrates the interaction between science and society based on at least one of the key concepts of science as a human endeavour. You will also consider what you think will be its impact on society with an appropriate justification. Appropriate referencing is expected.

Description of assessment

Your scientific communication can be in any of the following formats:

- Written report
- Oral presentation
- Informative video
- Pod cast
- An article for a scientific publication
- Any other form that meets the approval of your teacher.

The length of the task is a maximum of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

It needs to include:

1) **Introduction** that *briefly* outlines
   - the piece of hardware that is the focus,
   - the physics underpinning it
   - the Science as a Human Endeavour key concept(s) being explored
2) **Link between science and society**
   - Explanation of how this hardware (or the development of it) illustrates the interaction between science and society. Your explanation needs to address one or more of the 'key concepts of science as a human endeavour' dot points, found on the next page.
3) **Physics involved**
   - Detailed explanation of the Physics underpinning the hardware.
4) **Impact on Society**
   - Discussion of the potential impact of the computer hardware or equipment.

     Your discussion *may* consider:
     - What will be the cost to society?
     - On what scale will the impact be?
     - Will it be positive or negative for society?
     - Would it have an environmental impact?
     - Have an impact on our health and wellbeing?
     - An economic impact?
5) **Conclusion with justification**
   - Briefly outline what you think will be the impact and justify it.
6) An appropriate **Reference list**

Assessment conditions

This is an individual task that is to be completed within 2 weeks. It is to be submitted electronically through….

The following is the due dates for this investigation: (Note that the teacher will provide written feedback of the information that you provide in your outline)

Topic and SHE component/s explored	Written outline of task	Final report
Two days after commencing task	1 week after commencing	2 weeks after commencing

Key concepts of Science as a Human Endeavour

Communication and Collaboration

- Science is a global enterprise that relies on clear communication, international conventions, and review and verification of results.
- International collaboration is often required in scientific investigation.

Development

- Development of complex scientific models and/or theories often requires a wide range of evidence from many sources and across disciplines.
- New technologies improve the efficiency of scientific procedures and data collection and analysis. This can reveal new evidence that may modify or replace models, theories, and processes.

Influence

- Advances in scientific understanding in one field can influence and be influenced by other areas of science, technology, engineering, and mathematics.
- The acceptance and use of scientific knowledge can be influenced by social, economic, cultural, and ethical considerations.

Application and Limitation

- Scientific knowledge, understanding, and inquiry can enable scientists to develop solutions, make discoveries, design action for sustainability, evaluate economic, social, and environmental impacts, offer valid explanations, and make reliable predictions.
- The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment, and evaluation of risk, and provides opportunities for innovation.
- Science informs public debate and is in turn influenced by public debate; at times, there may be complex, unanticipated variables or insufficient data that may limit possible conclusions.

Performance Standards for Stage 2 Physics

	Investigation, Analysis, and Evaluation	Knowledge and Application
A	Designs a logical, coherent, and detailed physics investigation. Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively. Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification. Critically and logically evaluates procedures and discusses their effects on data.	Demonstrates a deep and broad knowledge and understanding of a range of physics concepts. Develops and applies physics concepts highly effectively in new and familiar contexts. Critically explores and understands in depth the interaction between science and society. Communicates knowledge and understanding of physics coherently, with highly effective use of appropriate terms, conventions, and representations.
B	Designs a well-considered and clear physics investigation. Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively. Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification. Logically evaluates procedures and their effects on data.	Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts. Develops and applies physics concepts mostly effectively in new and familiar contexts. Logically explores and understands in some depth the interaction between science and society. Communicates knowledge and understanding of physics mostly coherently, with effective use of appropriate terms, conventions, and representations.
C	Designs a considered and generally clear physics investigation. Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively. Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification. Evaluates procedures and some of their effects on data.	Demonstrates knowledge and understanding of a general range of physics concepts. Develops and applies physics concepts generally effectively in new or familiar contexts. Explores and understands aspects of the interaction between science and society. Communicates knowledge and understanding of physics generally effectively, using some appropriate terms, conventions, and representations.
D	Prepares the outline of a physics investigation. Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness. Describes data and undertakes some basic interpretation to formulate a basic conclusion. Attempts to evaluate procedures or suggest an effect on data.	Demonstrates some basic knowledge and partial understanding of physics concepts. Develops and applies some physics concepts in familiar contexts. Partially explores and recognises aspects of the interaction between science and society. Communicates basic physics information, using some appropriate terms, conventions, and/or representations.
E	Identifies a simple procedure for a physics investigation. Attempts to record and represent some data, with limited accuracy or effectiveness. Attempts to describe results and/or interpret data to formulate a basic conclusion. Acknowledges that procedures affect data.	Demonstrates limited recognition and awareness of physics concepts. Attempts to develop and apply physics concepts in familiar contexts. Attempts to explore and identify an aspect of the interaction between science and society. Attempts to communicate information about physics.

Stage 2 Physics
Skills and Applications Task 1

Name:_____

Purpose

This assessment provides you with the opportunity to demonstrate your ability to represent, analyse, and interpret investigations in physics through the use of technology and numeracy skills, communicate knowledge and understanding of the concepts and information of physics using the appropriate literacy skills of physics and demonstrate and apply knowledge and understanding of physics to a range of applications and problems relating to motion.

Description of assessment

You will use a computer program to analysis a range of videos of motion and answer a series of questions from subtopics 1.1 to 1.3. You will complete the assignment in a word processing program and submit your answers electronically at the end of the lesson. You should have the program "Tracker" installed on the computer which you will use to do this Skills and Application Task. You should be familiar with analysing motion of objects in a video with this program prior to beginning this task.

You need to:

- Communicate your knowledge and understanding clearly and concisely
- Use physics terms correctly
- Present information in an organised and logical sequence
- Include only information that is relevant to the question
- Use clearly labelled diagrams that are related to your answer
- Show all steps and reasoning in your answer
- Give answers with appropriate units, directions and significant figures

You may use the formula sheet provided to select appropriate formulae. In this assessment, vectors are shown with bold type.

Assessment conditions

You will have 90 minutes to complete this Skills and Application Task under the supervision of a teacher. You will only access the Tracker program and word processing software. You will have 5 minutes before the start of the task to read through the task sheet and load the required videos. These video are found on the school's server at ……

A calculator may be used.

Assessment Design Criteria and Specific Features

		A	B	C	D	E
Investigation, Analysis and Evaluation	IAE2	Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively.	Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively.	Obtains, records, and represents data, using generally appropriate conventions and formats with some errors but generally accurately and effectively.	Obtains, records, and represents data, using conventions and formats inconsistently, with occasional accuracy and effectiveness.	Attempts to record and represent some data, with limited accuracy or effectiveness.
	IAE3	Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification.	Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification.	Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification.	Describes data and undertakes some basic interpretation to formulate a basic conclusion.	Attempts to describe results and/or interpret data to formulate a basic conclusion.
Knowledge and Application	KA1	Demonstrates a deep and broad knowledge and understanding of a range of physics concepts.	Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts.	Demonstrates knowledge and understanding of a general range of physics concepts.	Demonstrates some basic knowledge and partial understanding of physics concepts.	Demonstrates limited recognition and awareness of physics concepts.
	KA2	Develops and applies physics concepts highly effectively in new and familiar contexts.	Develops and applies physics concepts mostly effectively in new and familiar contexts.	Develops and applies physics concepts generally effectively in new or familiar contexts.	Develops and applies some physics concepts in familiar contexts.	Attempts to develop and apply physics concepts in familiar contexts.
	KA4	Communicates knowledge and understanding of physics coherently, with highly effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of physics mostly coherently, with effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of physics generally effectively, using some appropriate terms, conventions, and representations.	Communicates basic physics information, using some appropriate terms, conventions, and/or representations.	Attempts to communicate information about physics.

Video One

Open the video "basketball" within the Tracker program. Track the motion of the basketball from frame 7 to frame 43. Put the coordinate axis at the location of the ball in frame 7. Use the 2.0-metre-long blue stick (pictured below) shown in the video where the floor meets the wall to calibrate the distance. The video has 30 frames every second.

Question 1

a) Take a screenshot capture of the track of the basketball. Show that the horizontal component of the velocity of the basketball is constant (after it has left the basketball player's hands). Include the screenshot in your answer below.

(3 marks)

b) Explain, using your knowledge of projectile motion, why the basketball has constant horizontal velocity.

(2 marks)

c) State the time of flight of the projectile during these frames

(2 marks)

d) State the average horizontal velocity of the basketball using the "v_x" data in Tracker.

(1 marks)

e) Calculate the range of the basketball between frames 7 and 43 using parts c) and d) only.

(2 marks)

Question 2

Predict, giving a logical explanation, the effect on the maximum range and time of flight if the basketball player was to release the ball while jumping higher in the video.

(4 marks)

Question 3

a) By rotating the coordinate axis in Tracker, find, and state below, the approximate launch angle of the basketball.

(1 marks)

b) Using parts, a) iv) and vi) only, calculate the initial speed of the basketball.

(1 marks)

c) Calculate the initial vertical component of the velocity by using appropriate equations learnt in class and the answers you have found so far.

(2 marks)

d) Calculate the maximum height of the basketball. (use $a = -9.8\ ms^{-2}$)

(2 marks)

Question 4

The basketball is replaced by a tennis ball, and is launched at the same angle and speed. Choose one feature of the tennis ball and explain how it will affect the maximum height obtained.

(4 marks)

Video Two

Open the video "video_student_riding_rocket" within the Tracker program. Track the motion of the student from frame 15 to 75, taking 5 frames at a time. Place the coordinate axis at an appropriate mark. Use the distance indicated in the video to calibrate the distance. The video has 30 frames every second. Assume constant acceleration throughout part two. Mass of student and cart is 105 kg.

Question 5

a) Using the "v_x" column in Tracker, state the final velocity of the student and cart.

(1 marks)

b) Calculate, using an appropriate formula, the change momentum of the student and cart.

(2 marks)

c) State the total change in momentum of all the CO_2 emitted.

(1 marks)

d) Using the law of conservation of momentum, explain how a spacecraft maybe accelerated by the emission of a gas such as CO_2.

(3 marks)

Video Three

Open the video "2ballcoll1" within the Tracker program. Track the motion of both billiard balls from frame 6 to 23, taking 2 frames at a time. Use two tracks for each ball, one before the collision and one after (4 tracks in total). Assume both balls are of equal mass.

Question 6

a) Derive a formula expressing the conservation of momentum for two billiard balls in a collision.

(3 marks)

b) Show that the momentum is approximately conserved in the collision between the two billiard balls. Include a screenshot capture of the billiard balls and vectors drawn in this program.

(5 marks)

Video Four

Open the video "rotating_wheel_mov" within the Tracker program. Track the motion of the blue circle from frame 286 to 296, taking two frames at a time.

Question 7

a) State the mean radius of the Blue circle.

(1 marks)

b) By playing the video so that the blue circle makes one full rotation, find its Period.

(1 marks)

c) Calculate the linear velocity of the blue circle, using an appropriate formula.

(2 marks)

d) By using a screenshot capture of the track (from frame 286 to 296), show that the change in velocity, hence acceleration, is towards the centre of the axis of rotation.

(4 marks)

Video Five

Open the video “a16v.1213311” within the Tracker program. From approximately frames 5684 to 5740, you can see the astronaut on the moon throwing an object, which reflects light at different points on its path. The height of the rectangular part of his back pack is 70 cm as picture aside.

Question 8

a) By using the change in the height of the object and an appropriate projectile motion formula, approximate the acceleration due to gravity on the moon.

(5 marks)

b) Using $g_{moon} = \frac{F}{m}$, calculate the acceleration due to gravity at the moon's surface. The mass of the moon is 7.35×10^{22} kg.

(1 marks)

c) State and explain one reason for the difference between the two values for the acceleration of gravity at the moon's surface.

(3 marks)

Video Six

Open the video “issatv19mar08m-b” within the Tracker program. This is a video of the European Space Agency's Jules Verne cargo carrier in front of the International Space Station (ISS) on March the 19th, 2008, seen from a city in Germany. The bright object that moves from the top right to bottom left from frame 302 is the ISS. The camera is taking 270 frames per second and the standard length of the measuring stick, that pops up when you insert one, needs to be changed to 139.4 m. Track the ISS from frames 313 to 321 taking 4 frames at a time. The radius of the Earth is 6.37×10^6 m and has mass of 5.97×10^{24} kg.

Question 9

a) Use the three steps created to calculate the velocity of the ISS.

(2 marks)

b) ISS is in a Near-Earth-circular orbit. Estimate the altitude (in kilometres) of ISS, using an appropriate formula.

(4 marks)

c) Use Kepler's 3rd law to estimate how long ISS takes to complete one full orbit of the Earth

(3 marks)

d) State and Explain one advantage of ISS in a Near-Earth orbit.

(3 marks)

Notes to teacher:

Before commencing this SAT, students should be familiar with, and have had practice in, analysing videos using the “Tracker” Video Analysis program. The program can be downloaded at http://physlets.org/tracker/. A good place for students to start is the following tutorial at https://www.youtube.com/watch?v=Dn0Zz7rtkZw.

Students computer will also need Java 1.6 or higher installed.

Students will need to be competent with writing equations into a word processing program of choice. (alternatively, students can submit part of this SAT electronically and part in hand written form)

It is advisable to encourage students to load all videos into the Tracker program during the reading time.

If possible, limit access to only the Tracker and word processing programs. Alternatively, if this is not possible at your school, constant observation of what students are accessing is essential, just as it is for a hand written SAT.

Marks are less than would normally be allocated in 90 minutes, this extra time is for the extra time required to manipulating the software.

The access to the following videos is needed: (It is suggested to share them on the local server or through the Learning Management System at your school)

Part	Name	Website
1	Basketball shot	http://physics.highpoint.edu/~atitus/videos/
2	video_student_riding_rocket	http://serc.carleton.edu/dmvideos/videos/student_riding.html
3	2ballcoll1	http://physics.doane.edu/physicsvideolibrary/movies/2ballcoll1.mov
4	rotating_wheel_mov	http://serc.carleton.edu/dmvideos/videos/rotating_disk.html
5	**Video Clip:** 121:33:11	http://www.hq.nasa.gov/alsj/a16/a16v.1213311.mpg
6	issatv19mar08m-b.mpeg (Needs to be converted to .mov file)	http://www.spaceweather.com/swpod2008/20mar08/issatv19mar08m-b.mpg?PHPSESSID=sotr4go74qbsjiqojf6eda00e3&PHPSESSID=0dlctfcdhq47ii6fsa1enu5a62 Original video from: http://www.theskyinmotion.com/issatv19mar08v.html

Stage 2 Physics
Skills and Applications Task 3

Name:_____

Purpose

This assessment provides you with the opportunity to demonstrate your ability to communicate your knowledge and understanding of physics concepts in electromagnetic induction. You will investigate how science informs public debate and demonstrate how scientific conclusions can be limited by the complex nature of the problem, unanticipated variables or insufficient data.

Description of assessment

You will use physics knowledge and understanding to prepare a feasibility statement for a complex situation involving concepts from subtopics 2.5. You will complete the assignment in a word processing program or electronic slide show and submit your answers electronically at the end of 50 minutes.

You need to:

- Communicate you knowledge and understanding clearly and concisely
- Use physics terms correctly
- Present information in an organised and logical sequence
- Include only information that is relevant to the question
- Use clearly labelled diagrams that are related to your answer
- Show all steps and reasoning in your answer
- Give answers with appropriate units, directions and significant figures

You may use the formula sheet provided to select appropriate formulae. In this assessment, vectors are shown with bold type.

Assessment conditions

You will have 50 minutes to complete this Skills and Application Task under the supervision of a teacher and 5 minutes to present the information. A calculator may be used.

Assessment Design Criteria and Specific Features

		A	B	C	D	E
Knowledge and Application	KA1	Demonstrates a deep and broad knowledge and understanding of a range of physics concepts.	Demonstrates some depth and breadth of knowledge and understanding of a range of physics concepts.	Demonstrates knowledge and understanding of a general range of physics concepts.	Demonstrates some basic knowledge and partial understanding of physics concepts.	Demonstrates limited recognition and awareness of physics concepts.
	KA2	Develops and applies physics concepts highly effectively in new and familiar contexts.	Develops and applies physics concepts mostly effectively in new and familiar contexts.	Develops and applies physics concepts generally effectively in new or familiar contexts.	Develops and applies some physics concepts in familiar contexts.	Attempts to develop and apply physics concepts in familiar contexts.
	KA3	Critically explores and understands in depth the interaction between science and society.	Logically explores and understands in some depth the interaction between science and society.	Explores and understands aspects of the interaction between science and society.	Partially explores and recognises aspects of the interaction between science and society.	Attempts to explore and identify an aspect of the interaction between science and society.
	KA4	Communicates knowledge and understanding of physics coherently, with highly effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of physics mostly coherently, with effective use of appropriate terms, conventions, and representations.	Communicates knowledge and understanding of physics generally effectively, using some appropriate terms, conventions, and representations.	Communicates basic physics information, using some appropriate terms, conventions, and/or representations.	Attempts to communicate information about physics.

About the Task

There is an urban tale, myth or not, about a farmer who had high voltage powerlines on his property (like the powerlines that provide South Australia with backup power from Victoria). He had a shed underneath these powerlines and noticed that a fluoro light tube, leaning up against a cupboard and not connected to any circuit, would light up. On investigation he discovered that he could get a coil of wire, placed in the shed and close to the powerlines but not connected or touching them, to deliver electrical power to lights and other electrical appliances.

The power company found out and he was taken to court for stealing electricity. He claimed that he had never touched the power company's property. That it was his equipment on his land and they couldn't prove that the electrical power was coming from their powerlines.

Your task, as an expert witness with extensive knowledge of electromagnetic induction theory, is to prepare a statement into the feasibility of this account above and present it as an oral to the classroom court.

You will have 50 minutes to prepare your feasibility statement at which time all expert witness statements will be handed in to the court administrator for secure assessment.

You will support your statement following this, or in the next court session. During this time, you will make it clear how science informs public debate and demonstrate how scientific conclusions can be limited by the complex nature of the problem, unanticipated variables, or insufficient data.

Credit will be given for the communication of the physics presented and also the demonstration of your knowledge and understanding of that physics.

You can use an electronic slide show to present the information or a word processer application, but you will not have access to the internet. Your presentation can be no longer than 5 minutes.

Some key points:

- The high voltage power lines have an alternating current. The peak potential difference is 275 kV with a peak alternating current of 700 A at a frequency of 50Hz
- The conducting lines are 25 m from the ground
- A Farm Implement Shed can be as high as 5 m (A shed that stores farming equipment like tractors and harvesters) and be as wide and high as desired.
- Copper wire is $2.60 per metre and the cost of 1kiloWatt hour of energy is approximately $0.35
- Household appliances run on a potential difference of 240 Volts
- You will need to make reasonable approximation of other quantities needed for your statement. Make sure to justify all assumptions.
- ***You will need to address how the conclusion of your statement may be limited.***
- One hint is you can use an average magnetic field to approximate a uniform field.
- You can use any formulas from the SACE Stage 2 formula sheet given. Below are some formulas you may find useful from Stage 1 Physics:
    - $P = \frac{\Delta E}{t}$
    - $P = VI$
    - $R = \frac{V}{I}$
    - $I = \frac{q}{t}$

  Where P is Power (Watts), E is energy (Joules), t is time (seconds), R is Resistance ($\Omega - \mathrm{Ohms}$), q is charge.

Stage 2 Sample Examinations (from 2018)

The purpose of these sample examinations is to provide an opportunity for teachers to familiarise themselves with the structure of the examination and the style and depth of questions to be expected.

The 2-hour examination will consist of two parts, each worth approximately 50% of the marks. There is a gradation in the difficulty of the questions with questions in Book 2 focusing more on analysis, evaluation, and application.

Please note:

- The questions in these sample papers have a bias towards content in the new subject outlines that is different from the 2017 subject outline to give teachers an understanding of depth of treatment that may be appropriate for the new concepts. In future examinations, it would be expected that there would be a balance of questions from across the subject outline.
- The total number of marks for the examination may vary slightly from year to year.
- The positioning of and the marks allocated to extended responses may vary from year to year.

Notes