2019 HSC Earth and Environmental Science Marking Guidelines

Section I

Multiple-choice Answer Key

Question	Answer
1	A
2	B
3	C
4	C
5	B
6	C
7	B
8	D
9	A
10	A
11	A
12	D
13	A
14	C
15	B
16	D
17	A
18	D
19	A
20	D

Section II

Question 21

Criteria	Marks
• Demonstrates an understanding of Aboriginal Peoples or Torres Strait Islander Peoples as sustainable resource managers • Makes judgements supported by arguments regarding the sustainability of their processes • Provides appropriate examples which link the judgements to sustainable resource management • Uses specific and appropriate terminology and progression of thought	5
• Demonstrates a detailed knowledge of Aboriginal Peoples or Torres Strait Islander Peoples as sustainable resource managers • Makes a judgement supported by arguments regarding the sustainability of their processes • Provides appropriate examples which link the judgements to sustainable resource management • Uses appropriate terminology and progression of thought	4
• Recalls basic knowledge of Aboriginal Peoples or Torres Strait Islander Peoples as sustainable resource managers • Makes a judgement regarding the sustainability of their processes • Provides a link between the judgements and sustainable resource management • Uses suitable terminology and progression of thought	3
• Provides some information on Aboriginal Peoples or Torres Strait Islander Peoples as sustainable resource managers	2
• Provides some relevant information	1

Sample answer:

Sustainable resource management refers to the usage of a resource such that the resource is not used up and is therefore available for use by future generations.

Aboriginal Peoples or Torres Strait Islander Peoples have traditionally demonstrated an effective use of resources that has been sustainable over a long period of time.

One example of such a process includes the way in which Aboriginal Peoples move around their Country guided by seasonal changes and breeding patterns of native flora and fauna. This ensures that, the population hunted or harvested has time to regenerate before the next visit. This demonstrates an effective sustainability practice because of the maintenance of populations for future use.

Another practice used by Aboriginal Peoples in the east was that of fire stick farming. Aboriginal People used certain burn patterns to ensure native animal habitats were not completely destroyed by extreme fires because of fuel build up. Therefore, sustaining the population of the animals that they ate and the regeneration of useful plant species, this practice demonstrates they were sustainable managers of their environment because stable ecosystems were maintained.

Overall, the practices outlined are examples of how indigenous peoples maintained sustainable resources for use over generations.

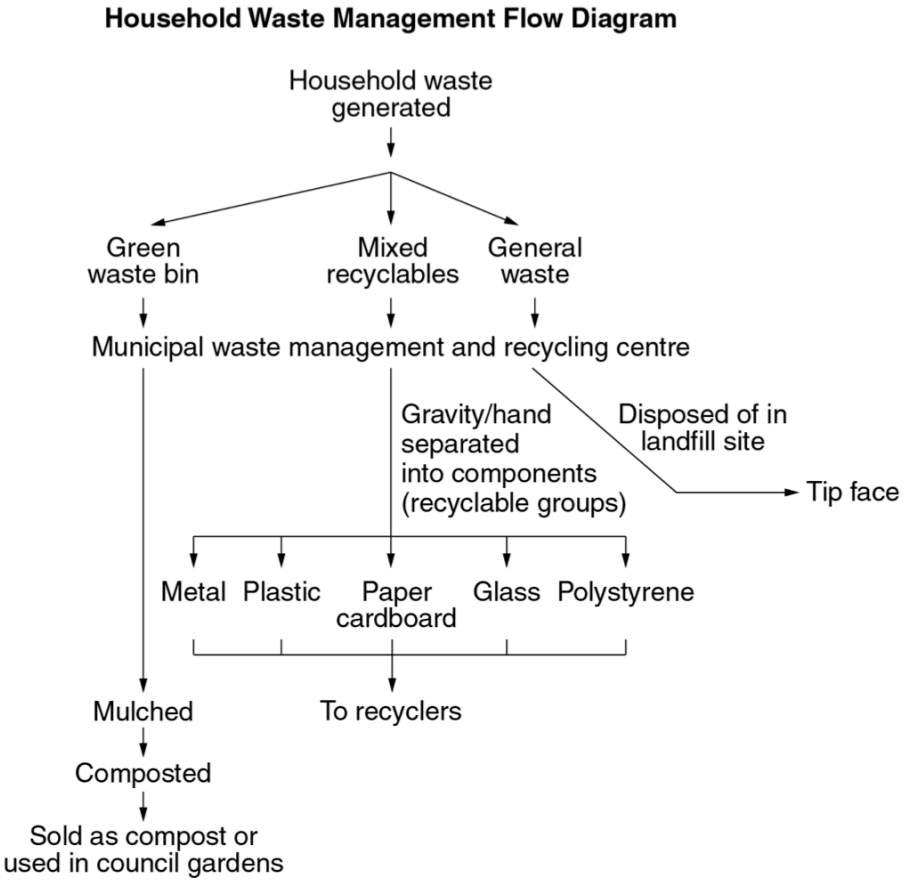
Answers could include:

- Land councils' negotiations over proposed developments
- Conservation of places of cultural significance
- Seeking legislation.
- Totems, fish farming, transport of eels/fisheries
- Middens as indicators.

Question 22

Criteria	Marks
• Completes a fully labelled flow diagram which summarises the processes involved in a solid waste management strategy	5
• Completes a labelled flow diagram which summarises most of the processes involved in a solid waste management strategy	4
• Completes a flow diagram with some labels which summarises some of the processes involved in a solid waste management strategy OR • Gives detailed information on processes involved in solid waste management	3
• Completes part of a flow diagram which represents at least one process involved in a solid waste management strategy OR • Gives information on processes involved in solid waste management	2
• Provides some relevant information	1

Sample answer:



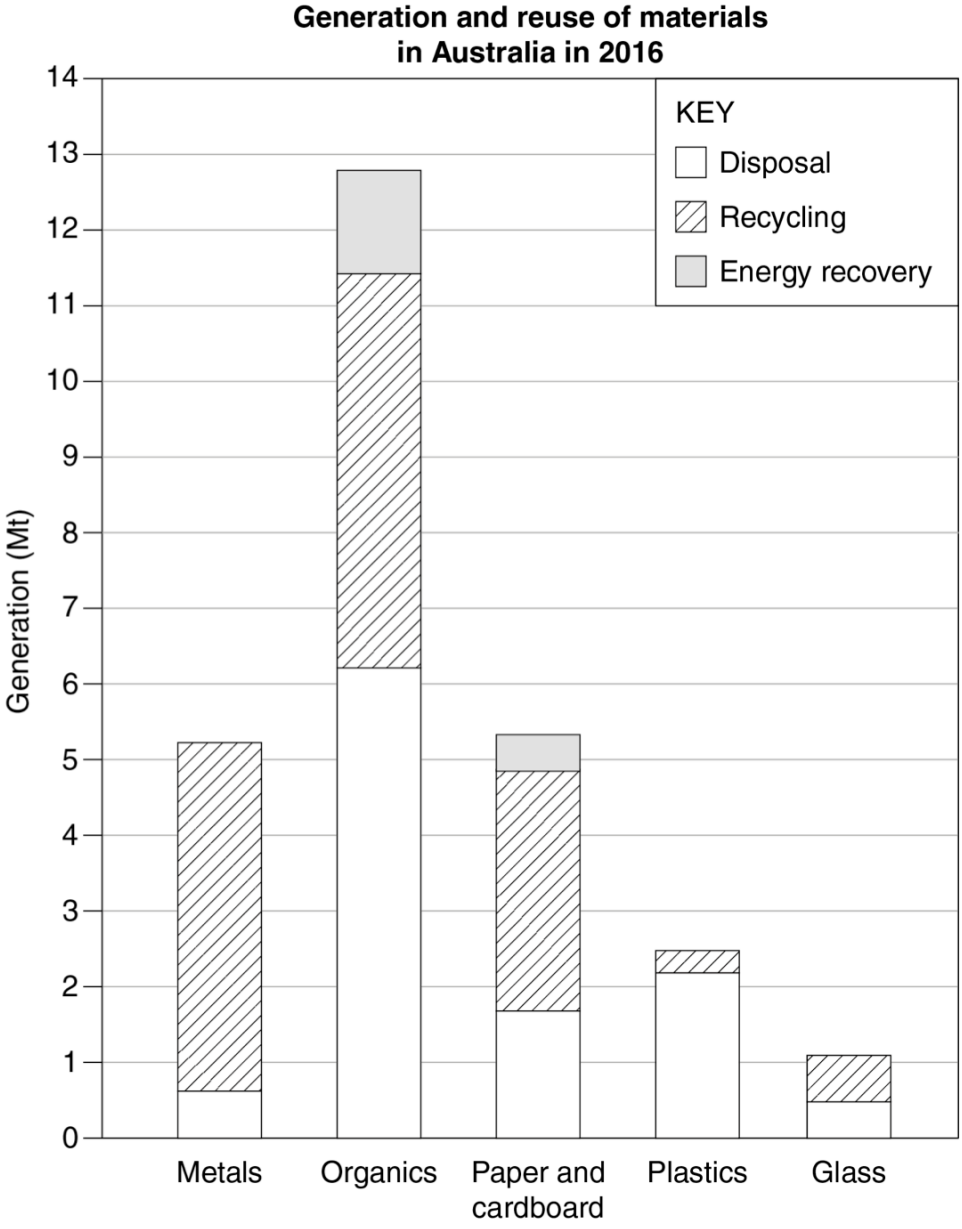
Flow diagram could include:

- Source separation
- Council sorting
- Recycling stream
- Non-recycling stream (disposal)
- Composting of green waste.

Question 23 (a)

Criteria	Marks
• Completes the graph correctly	3
• Completes some of the graph correctly	2
• Provides some relevant information	1

Sample answer:



Question 23 (b)

Criteria	Marks
• Completes all of the table correctly	2
• Completes some of the table	1

Sample answer:

Material class	*Energy recovery* (Mt)	*Recycling* (Mt)	*Generation* (Mt)	*PTR* (%)
Metals	0.0	4.6	5.2	88.5
Organics	1.4	5.2	12.8	51.6
Paper and cardboard	0.5	3.2	5.3	69.8
Plastics	0.02	0.3	2.5	12.8
Glass	0.0	0.6	1.1	54.5

Question 23 (c)

Criteria	Marks
• Identifies the material with lowest PTR • Describes a strategy to improve recovery rate • Justifies the use of the strategy	3
• Identifies the material with lowest PTR • Outlines a strategy to improve recovery rate • Justifies the use of the strategy OR • Identifies the material with the lowest PTR • Describes a strategy to improve recovery rate OR • Describes a strategy to improve the recovery rate of a category other than plastics	2
• Provides some relevant information	1

Sample answer:

The plastics category has the lowest PTR. One strategy that would improve the recovery rate of this category would be to introduce a refundable deposit for all plastic containers. This strategy would encourage more people to recycle more plastic containers and the recovery rate for the plastics category would increase.

Question 24 (a)

Criteria	Marks
• Completes all of the table correctly	4
• Completes most of the table correctly	3
• Completes some of the table correctly	2
• Gives some relevant information	1

Sample answer:

Unit	*Lithology*	*An index Fossil*	*Proportion Potassium-40 remaining*	*Geological Period*	*Absolute age in millions of years*
1	***Dolerite***		0.99	***Neogene***	***20***
2	Basalt		0.96	Cretaceous	80
3	Sandstone	Perisphinctes tiziani		Jurassic	
4	Muddy limestone	**Tropites subbullatus**		Triassic	
5	***Basalt***			***Triassic***	
6	Muddy limestone	**Tropites subbullatus**		Triassic	
7					
8	***Limestone***	Cystiphyllum niagarense		***Silurian***	
9	Shale	Tetragraptus fructicosus		Ordovician	
10	Granite		0.865	Permian	***270***

Also Monotis subcircularis at 4 and 6 is a correct answer.

Question 24 (b)

Criteria	Marks
• Suggests an age • Demonstrates a sound knowledge of dating methods • Links the features of the unit to dating techniques	4
• Suggests an age • Demonstrates a basic knowledge of dating methods • Links some features of the unit to dating techniques	3
• Provides information on absolute or relative dating OR • Gives reasons for the suggested age	2
• Provides some relevant information	1

Sample answer:

Suggested age is Devonian or Carboniferous. Unit 7 is conformable with units 6 and 8 and is probably a sedimentary rock. The Law of superposition would therefore be an appropriate method to determine the age of unit 7.

As Unit 7 is below Unit 6, it must be older than the Triassic. It's above Unit 8 and must be younger than Unit 8 which is Silurian. Unit 7 is intruded by Unit 10 which is of Permian age (270 million years old). Therefore Unit 7 has to be Devonian or Carboniferous.

If the unit was studied again and index fossils were found these could be used to give the best relative age.

Question 25

Criteria	Marks
• Demonstrates an understanding of reliability and includes repetition and similarity of results	2
• Provides some relevant information	1

Sample answer:

To test the reliability of data you would check if the investigation had been undertaken several times under identical circumstances and then look to see if the results were similar.

Question 26

Criteria	Marks
• Demonstrates a sound knowledge of the biosphere • Links changes in the biosphere to both changes in the atmosphere and hydrosphere • Provides numeric information from components of the graph	4
• Demonstrates some knowledge of the biosphere • Links changes in the biosphere to either changes in the atmosphere and banded iron formations • Provides numeric information from a component of the graph	3
• Demonstrates basic knowledge of the biosphere • Gives some information from the graph	2
• Provides some relevant information from the graph OR • Provides some relevant information about the biosphere	1

Sample answer:

The earliest photosynthetic organisms lived in water and any oxygen produced dissolved in the water and thus there was no oxygen in the atmosphere until 2.3 billion years ago. Until then dissolved oxygen combined with iron to form banded iron formations (BIF) with maximum BIF deposition occurring at 2.5 billion years ago. After 2.3 billion years ago, more oxygen was produced than was needed for BIF deposition and oxygen escaped to the atmosphere. There was a small increase in atmospheric oxygen levels, to present day levels, before 500 million years ago as photosynthetic organisms increased in number, in the hydrosphere, and eventually also in terrestrial environments. This increase in atmospheric oxygen eventually led to the production of ozone in the atmosphere. At 500 million years ago there was a rapid decrease in carbon dioxide from more than 1% of the atmosphere to approximately 700 ppm, possibly due to the evolution of land plants which consumed the gas as a reactant in the photosynthesis process.

Question 27

Criteria	Marks
• Compares of iridium content in rocks and meteorites • Refers to the data given • Links iridium to the stated theory	3
• Compares iridium content in rocks and meteorites	2
• Provides some relevant information	1

Sample answer:

The end-Cretaceous mass extinction occurred at the boundary between the Cretaceous and the Paleogene. It resulted in the disappearance of numerous organisms including all the dinosaurs. To support the theory that a meteor caused the extinction, the following criteria need to be met:

- the impact resulted in the disintegration of the meteor causing widespread distribution of the dust and particles from the meteor
- the dust and particles from the meteor had to become part of sediments at the time of impact
- since meteors have much higher iridium content, 0.05 ppm in this case, than normal terrestrial rocks, the sedimentary rocks deposited at the boundary should have a higher iridium content, that is, greater than 0.001 ppm due to the contamination of iridium from the meteor.

Question 28

Criteria	Marks
• Relates causes and effects of both tsunami and lahar production	4
• Relates cause and effect of either tsunami or lahar production • Describes both tsunami or lahar	3
• Describes either tsunami and lahar	2
• Gives some relevant knowledge	1

Sample answer:

Tsunami: These are waves of various sizes that result from an oceanic volcanic eruption, earthquake or landslide that causes the displacement of water. As earthquakes occur, water is displaced and the tsunami wave is formed.

Lahar: A type of flooding unique to volcanic eruptions. Fast flowing water mixes with ash and loose rubble. The water may come from melted snow and ice, displaced lakes or heavy rain during eruption. The mixture moves down slopes because of gravity.

Question 29

Criteria	Marks
• Demonstrates thorough knowledge and understanding of technologies used in predicting extreme weather events • Provides a thorough evaluation based on relevant and appropriate criteria	7
• Demonstrates sound knowledge and understanding of technologies used in predicting extreme weather events • Provides a sound evaluation based on relevant and appropriate criteria	6
• Demonstrates some knowledge and understanding of technology/technologies used in predicting extreme weather events • Provides a satisfactory evaluation based on relevant and appropriate criteria	4–5
• Demonstrates some knowledge of extreme weather events and technologies used to predict such events	2–3
• Provides some relevant information	1

Answers could include:

Extreme meteorological events such as: floods, coastal erosion, tornado, cyclone, hurricane, gale, storm surge, lightning, drought, snow storms, hail storms, heatwaves, east coast lows and thunderstorms.

Technologies such as: weather satellites, balloon aircraft or ship-borne instruments, doplar radar, thermometers, barometers, resistance temperature detectors (RTD), drifting ocean buoys, tipping bucket rain gauge.

Relevant and appropriate criteria such as cost, effectiveness, accuracy, accessibility and reliability.

Question 30 (a)

Criteria	Marks
• Links each boundary type to the depth at which earthquakes occur • States reasons why earthquakes occur at these depths	3
• Provides some knowledge about the depths at which earthquakes occur and boundary types	2
• Provides some relevant information	1

Sample answer:

Convergent boundaries typically produce deep focused earthquakes as the oceanic crust penetrates deep into the mantle. A divergent boundary found at a mid-ocean ridge is where the oceanic crust is relatively close to the surface and it will produce shallow focused earthquakes.

Question 30 (b)

Criteria	Marks
• Demonstrates sound knowledge and understanding of the similarities and/or differences between both types of volcanism and their effects on the biosphere and the atmosphere	4
• Demonstrates some knowledge of the similarities and/or differences between both types of volcanism and their effects on the biosphere and the atmosphere	3
• Demonstrates some knowledge of the similarities or differences between both types of volcanism and the effects of either on the biosphere or the atmosphere	2
• Provides some relevant information	1

Sample answer:

Biosphere	
Explosive volcanism	*Effusive volcanism*
• Massive destruction of local plants and animals with such hazards as lahars, tsunami and pyroclastic flows.	• Massive destruction of local plants and animals with such hazards as lava flows and acid rain.
Atmosphere	
Explosive volcanism	*Effusive volcanism*
• Typically a local and global impact on atmospheric composition due to the particles and gases emitted.	• Typically a local impact on atmospheric composition due to the limited dispersion of particles and gases emitted.

Answers could include:

Biosphere	
Explosive volcanism	*Effusive volcanism*
• Long-term impact on the fertility of local soil through mineral replenishment for the plants and animals.	• Long-term impact on the fertility of local soil through mineral replenishment for the plants and animals.
Atmosphere	
Explosive volcanism	*Effusive volcanism*
• A decrease in global temperature due to the extensive scale of the eruption and ash cloud.	• An increase in acid rain due to local weather patterns.

Question 31

Criteria	Marks
• Provides reasons why some scientists are investigating the current trend of increasing CO_2 • Compares the current trend of increasing CO_2 with past increases • Links the reasons for the current investigation to the differences between the current trend and past increases	4
• Provides reasons why some scientists are investigating the current trend of increasing CO_2 • Compares the current trend of increasing CO_2 with past increases	3
• Shows some understanding of the current trend of increasing CO_2 AND/OR • Shows some understanding of past increases of CO_2 AND/OR • Provides reason(s) why some scientists are investigating the current trend of increasing CO_2	2
• Provides some relevant information	1

Sample answer:

There have been periods through time when atmospheric CO_2 concentration has increased. For example, over the past 800 000 years up until the 1950s, CO_2 concentrations went up and down on multiple occasions varying within the range of approximately 170 to 300 ppm. The increases had been slow, spanning thousands of years. In contrast, atmospheric CO_2 concentrations have increased from 300 ppm to over 400 ppm over the last 70 years. In the past, the sources of atmospheric CO_2 have been natural, that is volcanic eruptions, asteroid bombardment, respiration and other natural processes. Nowadays, while these natural processes still occur more sources such as industries, cars, more livestock and greater world population emit CO_2. At the same time, there has been deforestation.

The differences between then and now are the magnitude of increase, the rate of increase and the sources of CO_2 and the lack of CO_2 sequestration due to deforestation. This is why some scientists are investigating the current trend of increasing atmospheric CO_2 to see how it may affect ecosystems.

Question 32 (a)

Criteria	Marks
• Provides the relationship between atmospheric and oceanic CO_2 • Outlines how carbonic acid is produced • Links increase in atmospheric CO_2 to increase in oceanic CO_2 and increase in acidification	3
• Provides the relationship between atmospheric and oceanic CO_2 • Links to changes in acidity	2
• Provides some relevant information	1

Sample answer:

CO_2 from the atmosphere normally dissolves in the ocean. Some of this CO_2 reacts with water to make carbonic acid. When there is extra CO_2 in the atmosphere, more will dissolve and react and more carbonic acid will be produced. Thus the oceans will become acidified.

Question 32 (b)

Criteria	Marks
• Describes an effect of ocean acidification	2
• Provides some relevant information	1

Sample answer:

The more acidic the ocean becomes, the more corrosive it becomes. This is likely to affect organisms that make their shells out of carbonate minerals, as carbonates will dissolve in acidic conditions.

Question 33 (a)

Criteria	Marks
• Describes how Aboriginal art can be used as evidence of the changing biodiversity of Australia	2
• Provides some relevant information	1

Sample answer:

Aboriginal art is a record of the animals and plants seen by the first Australians at the time the art was done. Thus over tens of thousands of years, the art gives the record of biodiversity seen at specific locations through time as rock art can be dated to give an absolute date to the presence of organisms pictured. This can be analysed for changes through time.

Question 33 (b)

Criteria	Marks
• Demonstrates a sound understanding of the formation of sedimentary rocks • Provides appropriate examples of how a scientist would study rocks • Links characteristics of rocks to information about past environments	4
• Demonstrates some knowledge about the formation of sedimentary rocks • Uses appropriate examples of how a scientist would study rocks • Links characteristics of rocks to information about past environments	3
• Demonstrates basic knowledge about the formation of sedimentary rocks OR • Links a characteristic of rocks to information about past environments • Provides one appropriate example of how a scientist could analyse rocks	2
• Provides some relevant information	1

Sample answer:

Rocks can tell you a range of things dependent on the type of analysis. Varves are changes in the thickness of layers that are a result of changing sedimentation rates. These changed rates are usually seasonal and due to influxes of meltwater/rainwater carrying sediment thus allowing scientists to get an idea of the environments producing the layers, eg the thicker layers of sediment may indicate when the meltwaters are flowing and carrying lots of fresh sediment with them for deposition. Fossil analysis can allow you to deduce marine and/or aquatic environments based on the types of fossils found. This also leads to certain environmental conditions being deduced through the presence of specific fossils and fossil assemblages. An example is the presence of coral fossils indicating shallow marine conditions. Further isotopic analysis of the ratio of O^{16} and O^{18} planktonic fossil shells can yield information about the global temperature. For example, the more O^{16} present the warmer the temperatures were, as usually the O^{16} is locked up in glaciers and ice and only released when these melt. The plankton that incorporate this O^{16} in their shells can become temperature indicators.

Question 34

Criteria	Marks
• Describes an appropriate method of geo-engineering • Makes a judgement supported by argument regarding the effectiveness of the chosen method for mitigating global temperature rise	3
• Describes an appropriate method of geo-engineering OR • Makes a judgement supported by argument regarding the effectiveness of the chosen method for mitigating global temperature rise	2
• Provides some relevant information	1

Sample answer:

Carbon capture and sequestration allows CO_2 to be extracted from industrial processes and forced into underground fluids where it is stored. This means the CO_2 is held underground instead of released into the atmosphere. This subsequently means it is not increasing the atmospheric concentration of CO_2 and thus not contributing to a rise in global temperature. This technique is effective in theory but is still largely experimental and very site specific so may not be utilised enough to make a significant impact.

Question 35

Criteria	Marks
• Demonstrates a depth or breadth and comprehension of knowledge and understanding of anthropogenic environmental problems • Shows how the application of multiple components of working scientifically has helped in terms of investigating problems and developing management strategies for the problems • Provides appropriate examples • Demonstrates a coherent and logical progression of thought and consistently uses appropriate scientific terminology	9
• Demonstrates a detailed knowledge and understanding of anthropogenic environmental problems • Shows how the application of working scientifically has helped in terms of investigating problems and developing management strategies for problems • Provides appropriate examples • Demonstrates a coherent and logical progression of thought and consistently uses appropriate terminology	7–8
• Demonstrates knowledge of anthropogenic environmental problems • Shows how the application of at least one of the working scientifically skills has helped in terms of investigating at least one problem and developing management strategies for the problem • Provides appropriate examples • Uses relevant terminology and/or progression of thought	5–6
• Recalls basic information regarding anthropogenic environmental problems • Gives examples of working scientifically • Uses suitable terminology	3–4
• Provides some relevant information	1–2

Answers could include:

Anthropogenic problems:

- Climate change (global warming, enhanced greenhouse effect)
- Ocean acidification/coral bleaching
- Land degradation due to farming practices eg salinity, erosion
- Depletion of ozone
- Decreasing biodiversity/Overharvesting
- Waste management
- Sustainable resource management/Mining degradation
- Water use and management
- Anthropogenic drought
- Human caused bushfire.

Scientists have used ‘working scientifically’ to understand and try to solve human caused environmental problems. One of the major problems facing Australia is climate variation.

To investigate climate variation scientists undertake questioning and predicting, planning investigations, conducting investigations. An example of this is where scientists have questioned if CO_2 is the cause for global warming. To see if this was true they planned investigations to collect data of different forms. Some data was collected via weather balloons to measure atmospheric CO_2 levels, and some data was collected from ice cores which allowed scientists to sample the atmosphere back through time to compare current CO_2 levels with pre-human levels.

Processing data and information, analysing data and information they found that there was an increase in the amount of atmospheric CO_2 in the current atmosphere and a correlation between the increase in CO_2 and temperature.

This knowledge is used to encourage the development of management strategies such as renewable energy sources including solar and wind power. These emerging technologies can be analysed for their efficiency and greenhouse emissions as an alternative to established fossil fuel use. Problem solving is a working scientifically skill used to develop management strategies. Scientific communication of these strategies in educating the public is important to influence change in practice.

2019 HSC Earth and Environmental Science Mapping Grid

Section I

Question	Marks	Content	Syllabus outcomes
1	1	Mod 8 – Using Australia's Natural Resources	EES12-15
2	1	Mod 8 – Sustainability	EES12-14
3	1	Mod 6 – Impact of Natural Disasters on the Biosphere	EES12-13
4	1	Mod 7 – Evidence for Climate Variation	EES12-14
5	1	Mod 5 – Development of the Biosphere	EES12-5, EES12-12
6	1	Mod 5 – Development of the Biosphere	EES12-5, EES12-12
7	1	Mod 6 – Geological Natural Disasters	EES12-7
8	1	Mod 6 – Impact of Natural Disasters on the Biosphere	EES12-6, EES12-13
9	1	Mod 5 – Fossil Formation and Stratigraphy	EES12-6, EES12-12
10	1	Mod 7 – Evidence for Climate Variation	EES12-5, EES12-14
11	1	Mod 7 – Evidence for Climate Variation	EES12-6, EES12-14
12	1	Mod 7 – Influence of Human Activities on Changes to Climate	EES12-5, EES12-12, EES12-14
13	1	Mod 8 – Using Australia's Natural Resources	EES12-5, EES12-15
14	1	Mod 8 – Using Australia's Natural Resources	EES12-5, EES12-15
15	1	Mod 5 – Plate Tectonic Supercycle	EES12-5, EES12-12
16	1	Mod 7 – Influence of Human Activities on Changes to Climate	EES12-5, EES12-12, EES12-14
17	1	Mod 8 – Using Australia's Natural Resources	EES12-6, EES12-15
18	1	Mod 6 – Geological Natural Disasters	EES12-5, EES12-13
19	1	Mod 6 – Impact of Natural Disasters on the Biosphere	EES12-5, EES12-13
20	1	Mod 5 – Development of the Biosphere	EES12-5, EES12-12

Section II

Question	Marks	Content	Syllabus outcomes
21	5	Mod 8 – Sustainability	EES12-7, EES12-15
22	5	Mod 8 – Waste Management	EES12-4, EES12-7, EES12-15
23 (a)	3	Mod 8 – Using Australia's Natural Resources	EES12-4, EES12-15
23 (b)	2	Mod 8 – Using Australia's Natural Resources	EES12-4, EES12-15
23 (c)	3	Mod 8 –Waste Management	EES12-5, EES12-15
24 (a)	4	Mod 5 – Fossil Formation and Stratigraphy	EES12-4, EES12-5, EES12-12
24 (b)	4	Mod 5 – Fossil Formation and Stratigraphy	EES12-5, EES12-6, EES12-12
25	2	Data Analysis	EES12-5
26	4	Mod 5 – Changes in the Geosphere, Atmosphere and Hydrosphere	EES12-5, EES12-12
27	3	Mod 5 – Fossil Formation and Stratigraphy	EES12-5, EES12-7, EES12-12

Question	Marks	Content	Syllabus outcomes
28	4	Mod 6 – Geological Natural Disasters	EES12-7, EES12-13
29	7	Mod 6 – Prediction and Prevention of Natural Disasters	EES12-6, EES12-7, EES12-13
30 (a)	3	Mod 6 – Geological Natural Disasters	EES12-7, EES12-13
30 (b)	4	Mod 6 – Impact of Natural Disasters on the Biosphere	EES12-4, EES12-7, EES12-13
31	4	Mod 7 – Evidence for Climate Variation	EES12-5, EES12-6, EES12-14
32 (a)	3	Mod 7 – Influence of Human Activities on Changes to Climate	EES12-7, EES12-14
32 (b)	2	Mod 7 – Influence of Human Activities on Changes to Climate	EES12-6, EES12-14
33 (a)	2	Mod 7 – Evidence for Climate Variation	EES12-5, EES12-14
33 (b)	4	Mod 7 – Evidence for Climate Variation	EES12-5, EES12-6, EES12-14
34	3	Mod 7 – Mitigation and Adaptation Strategies	EES12-6, EES12-14
35	9	Working Scientifically Mod 7 – Influence of Human Activities on Changes to Climate Mod 8 – Sustainability	EES12-1, EES12-5, EES12-7, EES12-14, EES12-15