NSW Education Standards Authority

2022 HSC Earth and Environmental Science Marking Guidelines

Section I

Multiple-choice Answer Key

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

Section II

Question 21

Criteria	Marks
• Identifies similarities or differences • Supports similarities or differences with examples	3
• Identifies similarities or differences OR • Identifies one similarity or difference and supports with an example	2
• Identifies one feature of an *era* or *period* OR • Names an *era* or *period* correctly	1

Sample answer:

Eras are longer than periods, for example, the Cenozoic Era covers more than 60 Ma but the Quaternary Period only covers about 2 Ma.

Eras and Periods are both defined by major changes in evolution, for example, the Palaeozoic Era and Cambrian Period were both marked by the first appearance of hard-shelled animals.

Question 22

Criteria	Marks
• Explains how an increased capacity to capture carbon can reduce amount of carbon entering the atmosphere • Links atmospheric carbon to global warming • Makes a judgement of value of blue carbon ecosystems in terms of their role in slowing global warming	4
• Describes the role of carbon sinks in regulating carbon content in the atmosphere • Links role of carbon to global warming • Implies a judgement	3
• Outlines one feature of blue carbon ecosystems that makes them a better carbon sink than terrestrial ecosystems OR • Outlines how blue carbon ecosystems act as a carbon sink	2
• Provides some relevant information	1

Sample answer:

Blue carbon ecosystems are very important as they are able to store large amounts of carbon in their soils. This ability to store carbon in the soil prevents large amounts of carbon dioxide from entering the atmosphere, effectively slowing the rate of global warming as the carbon dioxide present in the atmosphere traps heat causing global warming.

Question 23

Criteria	Marks
• Discusses points for and/or against the use of a named waste management option • Demonstrates an understanding of sustainability • Relates points to the sustainability of the management option	4
• Describes an issue or point for or against the use of a named waste management option • Implies an understanding of sustainability • Relates point to sustainability of the management option	3
• Outlines an issue, point for or against the use of a waste management option	2
• Provides some relevant information	1

Sample answer:

The return-and-earn program has successfully kept a greater amount of resources such as aluminium in circulation reducing the need for further mining. This better preserves this resource for future generations. Many of the plastics retained through this program are not recycled. This may reduce the lifespan of landfill sites, reducing access for future generations.

Answers could include:

Composting, incineration, landfill, recycling.

Question 24 (a)

Criteria	Marks
• Names a volcano monitoring technology	1

Sample answer:

Seismometer

Answers could include:

One of the following: gas sensor, tilt meter, ground temperature sensor or global positioning system (GPS).

Question 24 (b)

Criteria	Marks
• Distinguishes hazards and disasters explicitly or implicitly • Outlines the function or operation of a relevant technology • Outlines the harmful effects of a volcanic hazard • Uses cause and effect relationships to link technology to a reduction in harm	4
• Identifies the function or operation of a relevant technology • Identifies a harmful effect of a volcanic hazard • Links the technology to a reduction in harm	3

• Any two of
  – Identifies the function or operation of a relevant technology
  – Identifies a harmful effect of a volcanic hazard
  – Links the technology to a reduction in harm
	2

• Identifies the function or operation of a relevant technology OR • Identifies the harmful effects of a volcanic hazard	1

Sample answer:

Volcanic hazards cannot be prevented but seismometers can predict an impending eruption by detecting deep magma movements. Predictions enable cities such as Naples to be evacuated, protecting people from suffocating ash eruptions thus reducing disastrous loss of life.

Question 25 (a)

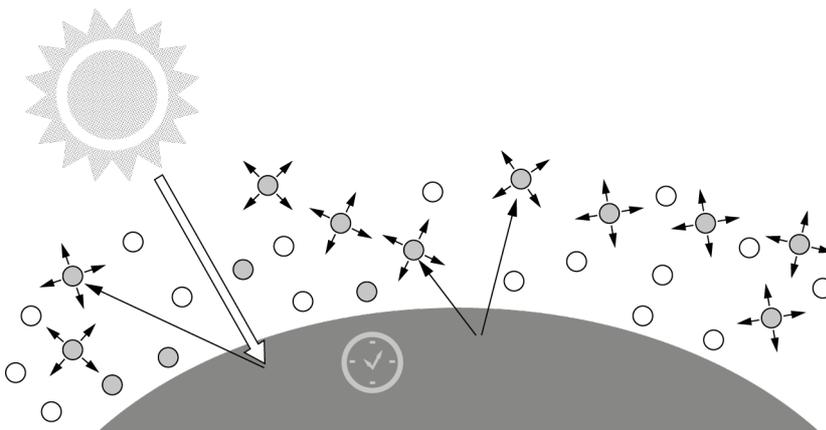| Criteria	Marks
• Explains the greenhouse effect • Refers to the model in explanation including the role of greenhouse gases and infrared radiation	3
• Describes the greenhouse effect • Refers to the model including the role of greenhouse gases and infrared radiation	2
• Identifies one feature of the greenhouse effect	1

Sample answer:

Sunlight, shown by the large arrow, is absorbed by the surface of the Earth, heating the Earth. The clock shows that some heat is later radiated away from the Earth in the form of infrared radiation. Some of this heat is trapped within the atmosphere as it strikes a greenhouse gas molecule and is scattered back through the atmosphere as shown by the short arrows in the model. This keeps the Earth and its atmosphere warm.

Question 25 (b)

Criteria	Marks

• Diagram shows clear changes to the original model
  – increased scattering of infrared radiation
  – increased number of greenhouse gases
• Clarifies and communicates a decrease in infrared escaping into space
	3

• Diagram shows TWO relevant changes	2
• Diagram shows ONE relevant change	1

Sample answer:

Question 26

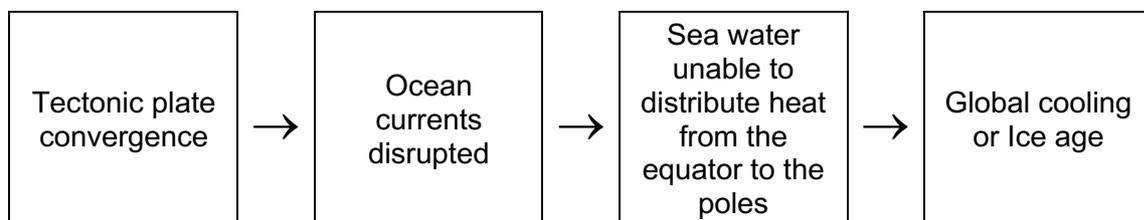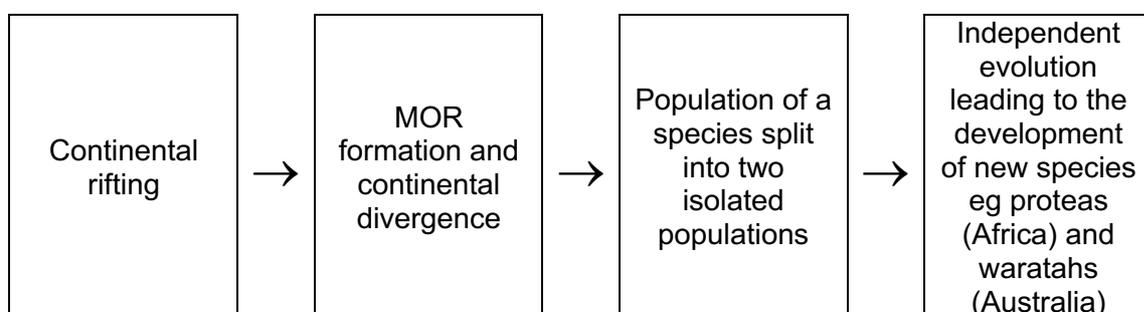| Criteria	Marks
• Identifies relevant component(s) of the plate tectonic supercycle • Identifies relevant component(s) of evolution or climate • Uses cause and effect to connect plate tectonic supercycle to evolution or climate • Uses a logical sequence • Creates a flow chart using a suitable format	4
• Identifies relevant component(s) of the plate tectonic supercycle • Identifies relevant component(s) of evolution or climate • Links the plate tectonic supercycle to evolution or climate • Uses a logical sequence • Creates a flow chart using a suitable format	3
• Identifies relevant component(s) of the plate tectonic supercycle • Identifies relevant component(s) of evolution or climate • Links the plate tectonic supercycle to evolution or climate	2
• Identifies relevant component(s) of the plate tectonic supercycle OR • Identifies relevant component(s) of evolution or climate OR • Creates a flow chart using a suitable format	1

Sample answer:

Plate tectonic supercycle affecting climate

Tectonic plate convergence	→	Ocean currents disrupted	→	Sea water unable to distribute heat from the equator to the poles	→	Global cooling or Ice age

OR

Plate tectonic supercycle affecting evolution

Continental rifting	→	MOR formation and continental divergence	→	Population of a species split into two isolated populations	→	Independent evolution leading to the development of new species eg proteas (Africa) and waratahs (Australia)

OR

A sequence of annotated diagrams in the form of a flow chart.

Question 27 (a)

Criteria	Marks
• Links high magnitude earthquakes to tectonic plate boundaries or low magnitude earthquakes to intra-plate faults • Uses cause and effect to link Australia's tectonic setting to earthquake magnitude	2
• Links high magnitude earthquakes to tectonic plate boundaries or low magnitude earthquakes to intra-plate faults OR • Identifies the tectonic setting of Australia	1

Sample answer:

High magnitude earthquakes usually occur on tectonic plate boundaries as the plates move relative to one another. There are no tectonic plate boundaries within the Australian continent, so high magnitude earthquakes are rare.

Question 27 (b)

Criteria	Marks
• Describes the effects of earthquakes on the biosphere and built environment • Makes a judgement as to the extent of effects on the biosphere and built environment	4
• Outlines the effects of earthquakes on the biosphere and built environment • Makes a judgement as to the extent of effects on the biosphere or built environment	3
• Outlines the effects of earthquakes on the biosphere or built environment	2
• Provides some relevant information	1

Sample answer:

Earthquakes cause the ground to shake. Most trees and plants can withstand some movement so they are rarely damaged. Animals may, in rare cases, be hit by falling branches. Microorganisms are usually unaffected. Earthquakes such as the 2021 Mansfield earthquake generally have little effect on the biosphere.

Australian earthquakes are rare and weak, so the Australian built environment contains rigid structures that are often not designed to withstand movement. Brick structures can crack. Power lines can fall. Earthquakes such as the 2021 Mansfield earthquake have the potential to cause major damage if they occur under built environments.

Question 28 (a)

Criteria	Marks
• Completes the score columns, subtotals and total score of the table • Uses data from the table to correctly calculate ecological footprint in square metres	3
• Completes most sections of the table • Attempts to calculate ecological footprint with some errors	2
• Provides some relevant information	1

Sample answer:

Water Use	Score	Energy	Score
My shower on a typical day is: ☐ 1–3 minutes long (50) ☐ 4–9 minutes long (70) ☑ more than 10 minutes OR bath (90)	90	To attend school, I travel by: ☐ car (200) ☑ public transport (40) ☐ bike or walking etc (5)	40
I flush the toilet: ☑ using the full flush (40) ☐ using the half flush (20)	40	I turn off the laptop/computer when not in use: ☐ yes (100) ☑ no (200)	200
When I brush my teeth, I: ☐ let the water run (40) ☑ turn the tap off (10)	10	In summer I often use a/an: ☐ fan (20) ☑ air conditioner (200)	200
When washing the dishes, I: ☐ hand wash (50) ☑ use a dishwasher (30)	30	Our home has solar panels: ☐ yes (subtract 100) ☑ no (50)	50
SUBTOTAL	170	SUBTOTAL	490
Food	**Score**	**Waste**	**Score**
My diet contains: ☑ meat or fish (150) ☐ vegetarian (80)	150	All of my weekly garbage could fit into a: ☑ snap lock bag (20) ☐ shopping bag (60) ☐ large garbage bag (200)	20
I compost my food scraps: ☐ yes (subtract 20) ☑ sometimes (20) ☐ never (60)	20	I recycle all of my paper, cans and glass: ☑ yes (subtract 20) ☐ sometimes (50) ☐ never (100)	−20
On a typical day I throw out: ☐ a small portion of my food (100) ☑ about half of my food (200)	200	I avoid disposable/single use items: ☑ yes (subtract 20) ☐ most of the time (50) ☐ never (100)	−20
SUBTOTAL	370	SUBTOTAL	−20
TOTAL SCORE	1 010		

Total score × 100 = ... 101 000 .... m²	

Question 28 (b)

Criteria	Marks
• Describes a strategy that could be implemented to reduce the ecological footprint, referencing part (a) • Provides a reason why this strategy will improve management of a named resource	4
• Describes a strategy that could be implemented to reduce the ecological footprint • Attempts to link to improved management of a named resource	3
• Outlines a strategy to reduce an ecological footprint	2
• Provides some relevant information	1

Sample answer:

The largest contributor to the ecological footprint was energy. A strategy for reducing air-conditioning use could be installing roller shutters on Cassie's windows to block out the sunlight. These shutters stop the house from heating up by blocking the sun's radiation. This would reduce her energy score by 200 points and reduce the electricity needed to power the air conditioner, consuming less coal, thus improving the management of a non-renewable resource.

Answers could include:

• Taking shorter showers / using grey water / using the half flush would lead to a reduction in use of water as a resource.
• Cooking smaller portions of food or meal planning may assist in reducing food wastage.
• Installing solar panels may reduce use of coal as a resource.

Question 29 (a)

Criteria	Marks
• Identifies ONE modification to the diagram • Outlines how the modification improves the diagram	2
• Provides some relevant information	1

Sample answer:

There are 23 years between 1962 and 1985 and 37 years between 1985 and today. This diagram could imply that each decline has occurred over the same time interval. The years should be distributed to scale so that the trend can be viewed over time.

Answers could include:

• Providing the number of eggs rather than having to work this out by counting the number of fish

• Identification of the source for validity.

Question 29 (b)

Criteria	Marks
• Outlines TWO trends in the data • Provides thorough reasoning for the trends	3
• Outlines at least ONE trend in the data • Provides sound reasoning for the trend OR • Outlines TWO trends in the data	2
• Provides some relevant information	1

Sample answer:

The average weight of snapper has decreased over time. This is because overfishing has removed snapper before they can grow to a larger weight.

Snapper are laying fewer eggs because there are fewer old fish and older fish are the best breeders.

Question 30 (a)

Criteria	Marks
• Provides details about changing temperatures and ^{18}O over time • Makes reference to data provided in the graph	3
• Describes one trend making reference to the graph OR • Identifies trends from the graph(s)	2
• Any relevant information from the graph	1

Sample answer:

Global temperatures remain relatively stable between 1440 and 1800 CE, however, since 1800 there has been a marked increase in global temperatures.

The relative amount of ^{18}O isotopes in stalagmites has shown a general increase in concentration from 1690 to 1950.

Question 30 (b)

Criteria	Marks
• Provides a valid explanation addressing the inconsistency in data trends	3
• Attempts to provide an explanation for an identified inconsistency	2
• Identifies a relevant inconsistency	1

Sample answer:

The relative increase in oxygen ^{18}O isotopes from stalagmites in Namibia implies an overall increase in temperature since 1690 while the global temperatures have only shown an increasing trend since mid-1800s. This is most likely due to the oxygen isotopic data coming from one small region in Africa. This does not reflect global trends as it has only been collected from localised data rather than data collected globally.

Answers could include:

• Differences in overall trend of ^{18}O and global temperature
• Size of fluctuations.

Question 31

Criteria	Marks
• Identifies variables explicitly or implicitly • Describes all of the requirements for a valid procedure • Provides a clear and logical sequence	7
• Outlines most of the requirements for a valid procedure • Provides a clear and logical sequence	5–6
• Outlines some of the requirements for a valid procedure	3–4
• Identifies some aspects of relevant experimental procedure	2
• Identifies one aspect of relevant experimental procedure	1

Sample answer:

Separate the cyanobacteria into ten equal samples. Place each sample under a funnel as shown in the diagram, ensuring no air is trapped in the measuring cylinder. Number the beakers 1−10.

Changing and measuring the independent variable (light)
Place each sample in a lightproof cupboard. Beaker 1 (the control) should be left in the dark. Illuminate samples 2−10 with a lamp. Set lamp 2 to minimum brightness and set lamps 3−10 progressively brighter with lamp 10 set to maximum. Use a light meter in each cupboard to measure light levels throughout the experiment.

Managing controlled variables
Weigh each cyanobacteria sample to exactly one gram. Use markings on the beakers to ensure each sample has the same quantity of water. Use cupboards in the same room to ensure consistent temperature. Give each sample the same time to photosynthesise between set-up and oxygen measurement.

Measuring the dependent variable (oxygen production)
Measure the displaced water level in each measuring cylinder after one week to show oxygen production.

Safety
Clean water spills promptly to avoid slips and falls. Take care with glass to avoid breakages and cuts.

Question 32 (a)

Criteria	Marks
• Sketches in general terms how a land management practice can reduce or increase the magnitude of bushfires	2
• Provides some relevant information	1

Sample answer:

Indigenous cool burns undertaken at night or in the morning when the ground is dewy are easier to manage than hazard reduction burns. These cool burns reduce the underbrush, clearing areas of land, leading to less fuel for bushfires and lower magnitude fires.

Answers could include:

• Construction of firebreaks

• Weed management to reduce invasive introduced species

• Maintenance of fire trails.

Question 32 (b)

Criteria	Marks
• Explains a change to the biosphere specifically related to the images provided • Links how this change affects the atmosphere and climate	4
• Outlines a change to the biosphere specifically related to the images provided • Links how this change affects the atmosphere and climate	3
• Describes changes to the biosphere, atmosphere or climate	2
• Provides some relevant information	1

Sample answer:

Bushfires burn large areas of vegetation. The combustion of this component of the biosphere releases carbon dioxide and causes vast smoke plumes, as shown in the second diagram, to rise into the atmosphere temporarily altering its composition, increasing air pollution, and reducing solar radiation reaching the surface of the Earth, causing temperature to drop by several degrees. Smoke from extreme fire events can reach the upper atmosphere and result in smoke-induced global cooling, thus affecting climate.

Question 32 (c)

Criteria	Marks
• Describes the effect a change in the biosphere can have on the sustainability of resources • Infers specific consequences of the change and effect on the sustainability of resources	3
• Outlines a change in the biosphere • Infers a consequence on sustainability	2
• Provides some relevant information	1

Sample answer:

Severe bushfires can destroy agricultural crops and forestry plantations. The destruction of plant life results in soil erosion due to the loss of roots holding soil together. Soil degradation reduces the long-term production of food resources. Burnt forests reduce the medium-term availability of timber resources because trees can take decades to grow back.

Question 32 (c)

Question 33 (a)

Criteria	Marks
• Labels axes including units • Plots points correctly in a scatter (line) graph • Provides a smooth trend line / line of best fit	3
• Provides any TWO of the above OR • Plots a column (or other style) graph correctly	2
• Provides at least ONE correct component of the graph	1

Sample answer:

Shellharbour Airport – MSLP 16–27 March 2021
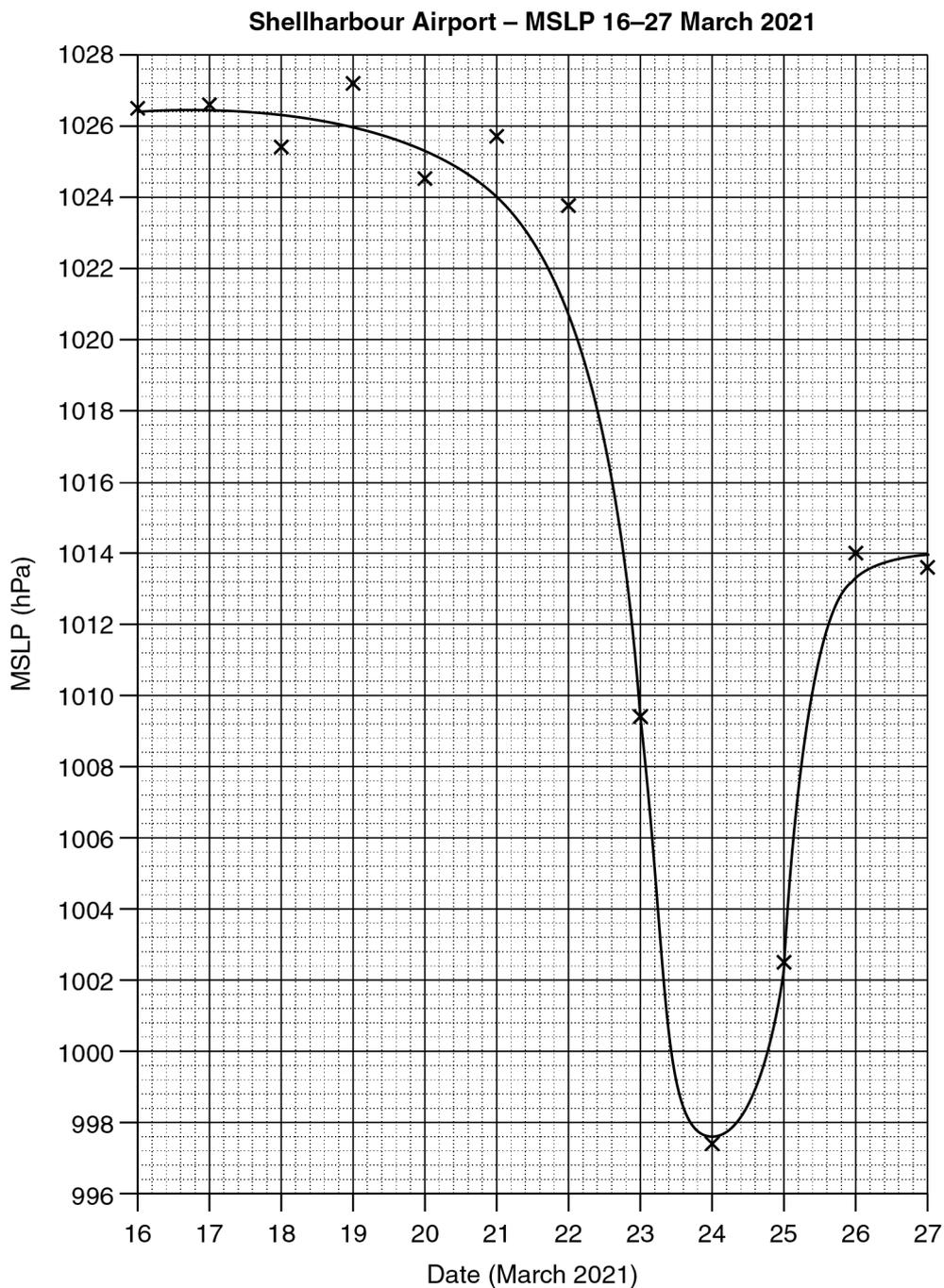
Question 33 (b)

Criteria	Marks
• Outlines the impact of meteorological technology • Links technology clearly to prediction of weather • Integrates relevant data into response • Provides a judgement of effectiveness	4
• Links technology to prediction of weather • Identifies relevant data • Provides a judgement of effectiveness	3
• Links technology to prediction of weather • Identifies relevant data	2
• Provides some relevant information	1

Sample answer:

Technologies such as barometers are used to measure air pressure. Changes in pressure can be used to predict weather events. The rainfall weather event is associated with a drop in air pressure but the pressure reached a minimum of 997.4 hPa on 24/3/21, two days after the heaviest rainfall (~65 mm on 22/3/21). A single barometer is not always effective in predicting rainfall.

Question 34

Criteria	Marks
• Provides a detailed description of changes in the biosphere • Identifies a relevant factor and clearly relates it to the origin of the biosphere • Identifies relevant factors and clearly relates them to developments in the biosphere • Integrates relevant examples into the response • Provides a logical, coherent and concise progression of ideas	7
• Describes changes in the biosphere • Identifies a relevant factor(s) and relates it to the origin of the biosphere • Identifies relevant factors and relates them to developments in the biosphere • Uses examples to support the response • Provides a logical and coherent progression of ideas	5–6
• Outlines change(s)/development(s) in the biosphere and identifies an example • Identifies a relevant factor and links it to the origin of the biosphere OR to a development in the biosphere	3–4
• Outlines a development in the biosphere and identifies an example OR • Outlines a relevant factor	2
• Identifies a development in the biosphere OR • Identifies a relevant factor OR • Outlines the relevance of an example	1

Sample answer:

Organic molecules found around black smokers in the ancient oceans organised themselves into simple cells which were able to obtain energy using chemicals emitted by the black smokers. Over time these cells evolved into photosynthesising cyanobacteria which can be found within ancient stromatolites. The development of hard body parts in organisms such as the Cambrian trilobites provided protection and greater mobility allowing fauna such as the labyrinthodont to move into terrestrial environments. This allowed the Earth's biosphere to diversify as fauna inhabited a whole range of new and different ecosystems, eventually creating our present biosphere.

Answers could include:

Formation of organic molecules (Urey−Miller, black smokers or panspermia); photosynthetic cyanobacteria; the development of multicellular Ediacaran metazoans; the Cambrian explosion; the conquest of land; changes to the geosphere, atmosphere or hydrosphere; plate tectonic super cycle.

2022 HSC Earth and Environmental Science Mapping Grid

Section I

Question	Marks	Content		Syllabus outcomes
1	1	Mod 5	Changes to the Geosphere, Atmosphere and Hydrosphere	12-12
2	1	Mod 7	Influence of Human Activities on Changes to Climate	12-14
3	1	Mod 8	Waste Management	12-15
4	1	Mod 6	Impact of Natural Disasters on the Biosphere	12-13
5	1	Mod 7	Mitigation and Adaptation Strategies	12-14
6	1	Mod 5	Fossil Formation and Stratigraphy	12-12
7	1	Mod 5	Fossil Formation and Stratigraphy	12-7, 12-12
8	1	Mod 6	Geological Natural Disasters	12-13
9	1	Mod 7	Evidence for Climate Variation	12-14
10	1	Mod 8	Sustainability	12-4, 12-15
11	1	Mod 8	Sustainability	12-5, 12-15
12	1	Mod 8	Sustainability	12-7, 12-15
13	1	Mod 5	Development of the Biosphere; Plate Tectonic Supercycle	12-12
14	1	Mod 7	Influence of Human Activities on Changes to Climate	12-14
15	1	Mod 6	Prediction and Prevention of Natural Disasters	12-13
16	1	Mod 8	Using Australia's Natural Resources	12-5, 12-15
17	1	Mod 6	Impact of Natural Disasters on the Biosphere	12-6, 12-13
18	1	Mod 7	Mitigation and Adaptation Strategies	12-14
19	1	Mod 7	Natural Processes of Variations in Climate	12-14
20	1	Mod 6	Prediction and Prevention of Natural Disasters	12-6, 12-13

Section II

Question	Marks	Content		Syllabus outcomes
21	3	Mod 5	Fossil Formation and Stratigraphy	12-5, 12-12
22	4	Mod 7	Mitigation and Adaptation Strategies	12-5, 12-14
23	4	Mod 8	Waste Management	12-15
24 (a)	1	Mod 6	Prediction and Prevention of Natural Disasters	12-13
24 (b)	4	Mod 6	Prediction and Prevention of Natural Disasters	12-13
25 (a)	3	Mod 7	Natural Processes of Variations in Climate	12-6, 12-14
25 (b)	3	Mod 7	Natural Processes of Variations in Climate	12-6, 12-7, 12-14
26	4	Mod 5	Plate Tectonic Supercycle	12-7, 12-12
27 (a)	2	Mod 6	Impact of Natural Disasters on the Biosphere	12-13
27 (b)	4	Mod 6	Impact of Natural Disasters on the Biosphere	12-7, 12-13
28 (a)	3	Mod 8	Using Australia's Natural Resources; Waste Management; Sustainability	12-4, 12-15

Question	Marks	Content		Syllabus outcomes
28 (b)	4	Mod 8	Using Australia's Natural Resources; Waste Management; Sustainability	12-6, 12-15
29 (a)	2	Mod 8	Sustainability	12-5, 12-15
29 (b)	3	Mod 8	Sustainability	12-5, 12-15
30 (a)	3	Mod 7	Influence of Human Activities on Changes to Climate	12-5, 12-14
30 (b)	3	Mod 7	Influence of Human Activities on Changes to Climate	12-6, 12-7, 12-14
31	7	Mod 5	Changes in the Geosphere, Atmosphere and Hydrosphere	12-2, 12-12
32 (a)	2	Mod 6	Impact of Natural Disasters on the Biosphere	12-13
32 (b)	4	Mod 5	Changes in the Geosphere, Atmosphere and Hydrosphere	12-5, 12-12, 12-14
		Mod 7	Influence of Human Activities on Changes to Climate	
		Mod 7	Mitigation and Adaptation Strategies	
32 (c)	3	Mod 8	Sustainability	12-5, 12-15
33 (a)	3	Mod 6	Impact of Natural Disasters on the Biosphere	12-4, 12-13
33 (b)	4	Mod 6	Prediction and Prevention of Natural Disasters	12-4, 12-13
34	7	Mod 5	Development of the Biosphere	12-7, 12-12