
2021 HSC Earth and Environmental Science Marking Guidelines

Section I

Multiple-choice Answer Key

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

Section II

Question 21

| Criteria | Marks |
|---|-------|
| <ul style="list-style-type: none"> Describes TWO management options, one sustainable and one unsustainable | 4 |
| <ul style="list-style-type: none"> Describes ONE management option and outlines another management option OR <ul style="list-style-type: none"> Describes TWO sustainable or TWO unsustainable management options | 3 |
| <ul style="list-style-type: none"> Outlines TWO management options OR <ul style="list-style-type: none"> Describes ONE management option | 2 |
| <ul style="list-style-type: none"> Provides some relevant information | 1 |

Sample answer:

Waste type one: Used furniture

Sustainable: Local councils or community groups organised a social media network. This allowed members of their community to know that specific solid waste items, such as furniture or even plants, could be picked up for free and thus reused by those who wanted such items.

Waste type two: Old electrical appliances

Unsustainable: Extra solid household waste was taken up by an increased frequency of household curb side collections. This resulted in an increase in material going to landfill sites.

Question 22 (a)

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Identifies a renewable or non-renewable resource | 1 |

Sample answer:

Timber is an important renewable resource.

OR

Gold is an important non-renewable resource.

Question 22 (b)

| Criteria | Marks |
|--|-------|
| • Sketches in general terms how the resource is both found and extracted/harnessed | 3 |
| • Outlines how the resource is either found or extracted/harnessed | 2 |
| • Provides some relevant information | 1 |

Sample answer:

Since habitation of the continent the location of significant timber resources was found through exploration. This process continued with the arrival of Europeans. The extraction of timber was originally by hand but over the years significant infrastructure such as plantations and roads have been developed for the timber industry.

OR

In the past prospectors would pan for gold to identify likely alluvial or reef deposits. Once a viable deposit is found it is then mined. The gold is dug out of the ground, extracted and separated from the waste material in processing.

Question 22 (c)

| Criteria | Marks |
|---|-------|
| • Explains the importance of this resource to Australians | 3 |
| • Outlines the importance of this resource to Australians | 2 |
| • Provides some relevant information | 1 |

Sample answer:

Timber provides employment and contributes to the Australian economy in various industries, particularly the housing industry. This resource is also important environmentally as seen by the creation and maintenance of national parks.

OR

Gold provides employment and contributes to the Australian economy in various industries. This provides specific and flow-on employment opportunities.

Question 23

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Explains the effects of TWO identified hazards associated with earthquakes on the environment | 4 |
| <ul style="list-style-type: none"> Explains the effects of ONE identified hazard associated with earthquakes on the environment Identifies a second effect associated with earthquakes OR <ul style="list-style-type: none"> Describes the impact of two identified hazards associated with earthquakes | 3 |
| <ul style="list-style-type: none"> Identifies the impact of TWO hazards associated with earthquakes OR <ul style="list-style-type: none"> Provides details of ONE impact associated with earthquakes OR <ul style="list-style-type: none"> Explains TWO non-earthquake related natural hazards | 2 |
| <ul style="list-style-type: none"> Any relevant information associated with any natural hazard | 1 |

Sample answer:

Earthquakes generate a series of seismic waves which pass through the crust causing the ground to shake. This causes cracks in built structures and weakens foundations which can lead to the collapse of structures such as buildings and dams.

Tsunamis are generated by a shift in crustal slabs which moves the ocean above and causes massive waves which wipe out structures and ecosystems. This causes death and destruction as the surge carries large amounts of energy and debris.

Question 24

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Discusses the usefulness of the named strategy from the model Relates the strategy to mitigation of and/or adaptation | 4 |
| <ul style="list-style-type: none"> Describes a usefulness of a named strategy from the model | 3 |
| <ul style="list-style-type: none"> Outlines a named strategy from the model | 2 |
| <ul style="list-style-type: none"> Provides some relevant information | 1 |

Sample answer:

One way in which humans can build climate resilience is to employ alternative energy sources. By replacing coal-fired electricity with wind power you can reduce the amount of carbon dioxide entering the atmosphere without affecting the quality of life experienced by people. One downside to this is that the wind does not always blow and so excess energy generated by wind turbines would have to be stored in batteries or pumped hydro to be used at a later date. This strategy is currently employed in South Australia using the Tesla battery. By using this strategy people could reduce total carbon dioxide in the atmosphere leading to mitigation of emissions and later reduction in global temperatures.

Question 25

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> • Demonstrates a comprehensive knowledge AND understanding of the effects that human activities have had on sustainability • Clearly relates the effects to Australian resources • Provides two or more specific examples • Provides a clear judgement • Demonstrates logical progression of thought | 7 |
| <ul style="list-style-type: none"> • Demonstrates a thorough knowledge AND/OR understanding of the effects that humans have had on sustainability • Relates the effects to Australian resources • Provides two or more specific examples • Provides or implies a judgement | 5–6 |
| <ul style="list-style-type: none"> • Shows knowledge of the effects that human activities have had on sustainability AND/OR relates the effects to Australian resources • Provides one or two examples | 3–4 |
| <ul style="list-style-type: none"> • Outlines how human activities have affected sustainability | 2 |
| <ul style="list-style-type: none"> • Shows a basic knowledge of sustainability OR <ul style="list-style-type: none"> • Identifies a human activity that has affected Australian resources | 1 |

Sample answer:

Pollution of Australia's water resources could be catastrophic for entire ecosystems and could clearly affect the sustainability of this resource. This pollution could be caused by activities such as runoff of fertilisers from agriculture or the illegal disposal of waste. Water pollution can impact the life cycle of the plants and animals that live within the affected water systems, resulting in a significant reduction in the biodiversity and the quality of water for years into the future.

The granting of water allocations by government departments clearly impacts on the natural flows of water systems such as the Murray-Darling. This has been seen over recent years where communities that depend on the sustainability of water flows within that system have struggled to maintain a water supply during prolonged periods of drought because too much water has been removed upstream.

Answers could include:

Damming, Flood irrigation, Forestry, Fishing, Urban development, Agricultural practices, National Parks, Wildlife policies.

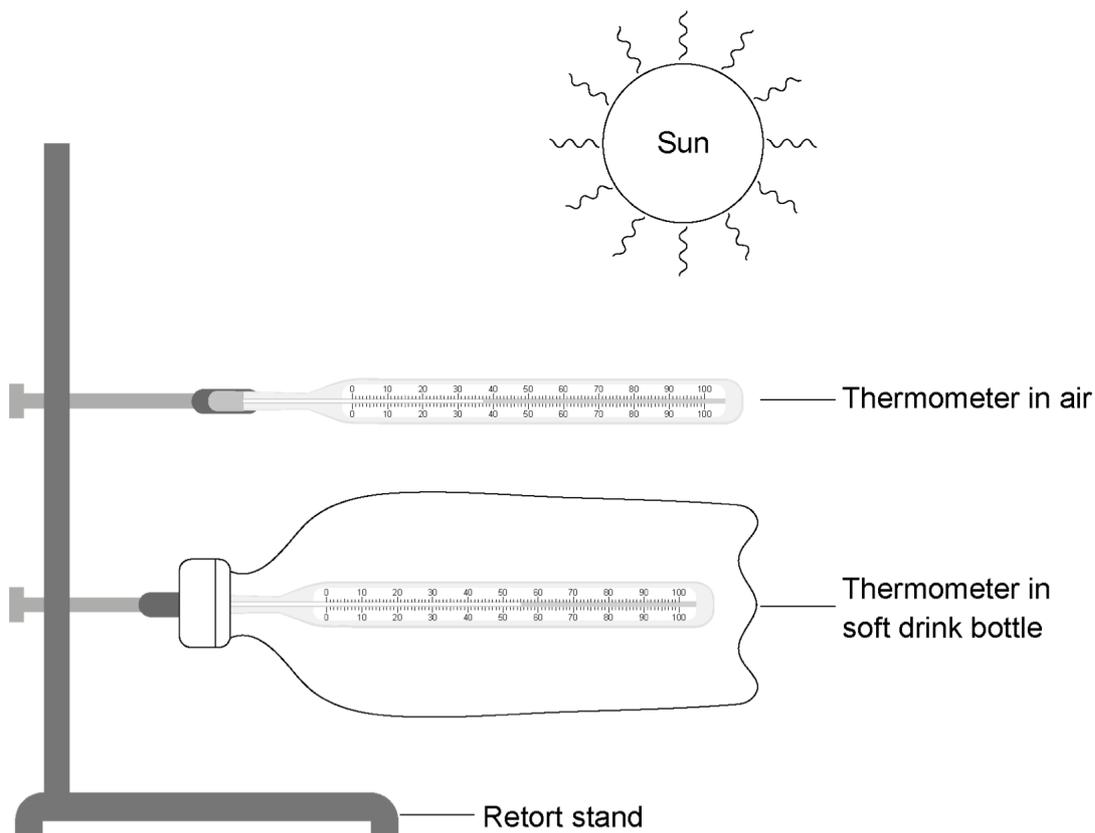
Bushfire management/mitigation through cultural burning, joint management with traditional owners, Indigenous rangers and caring for country programs.

Question 26 (a)

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Provides a labelled diagram/model that clearly demonstrates a cause of the natural greenhouse effect Describes a cause of the natural greenhouse effect | 4 |
| <ul style="list-style-type: none"> Describes a cause of the natural greenhouse effect and links the diagram/model to the description | 3 |
| <ul style="list-style-type: none"> Describes a cause of the natural greenhouse effect without any diagram/model <p>OR</p> <ul style="list-style-type: none"> Identifies appropriate diagram/model displaying basic understanding | 2 |
| <ul style="list-style-type: none"> Identifies an appropriate model | 1 |

Sample answer:

The diagram shows a simple model of the greenhouse effect. The thermometer in the air is a model for the atmosphere without greenhouse gases while the thermometer in the bottle is a model for the atmosphere with greenhouse gases, indicating the trapping of infrared radiation. The gases are represented by the bottle trapping heat and increasing the temperature within.



Answers could include:

Other models may include practical investigations.

Question 26 (b)

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Demonstrates a detailed knowledge and understanding of differences between the cause of natural and anthropogenic greenhouse effect | 4 |
| <ul style="list-style-type: none"> Describes natural and anthropogenic greenhouse effects with limited emphasis on the differences | 3 |
| <ul style="list-style-type: none"> Identifies a natural or an anthropogenic greenhouse effect OR <ul style="list-style-type: none"> Describes differences in causes of natural and anthropogenic greenhouse effect | 2 |
| <ul style="list-style-type: none"> Provides some relevant information on either natural or anthropogenic greenhouse effect | 1 |

Sample answer:

The natural greenhouse effect is an influence caused by natural levels of atmospheric carbon dioxide from volcanism or methane from peat bogs, moderating the extreme temperatures on the earth. Without it the earth would freeze at night and boil during the day.

The anthropogenic greenhouse effect has been occurring since the industrial revolution due to increased levels of carbon dioxide in the atmosphere caused by human activities such as the burning of fossil fuels. Similarly wide spread agricultural practices producing more methane and other industrial activities creating more greenhouse gases. It is causing climate changes beyond the natural averages with increased ferocity of storms and increased global temperature averages. The natural greenhouse effect has created a stable climate, while the anthropogenic greenhouse effect has destabilised the climate causing extremes in heat and icy weather systems.

Question 27

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Explains how two examples of scientific evidence indicate ancient variations in global temperatures | 5 |
| <ul style="list-style-type: none"> Describes one and explains the other example of scientific evidence indicating global temperatures in the ancient past | 4 |
| <ul style="list-style-type: none"> Describes TWO pieces of evidence indicating global temperatures in the past | 3 |
| <ul style="list-style-type: none"> Describes one example of evidence OR <ul style="list-style-type: none"> Outlines TWO examples | 2 |
| <ul style="list-style-type: none"> Provides some relevant information | 1 |

Sample answer:

We have indications of ancient global temperatures from a variety of sources. Biological sources like pollen grains and microscopic sea creatures as well as physical sources such as sedimentary rocks and isotope ratios in sediment can indicate ancient variations in global temperatures.

Pollens and spores are indicative of the plant life present on the earth. This information can be gleaned back to 400 Million years ago. The types of plants and their abundance indicate the related climate to the scientist.

Information from sediments can indicate past climate. For example the presence of drop-stones on the south coast sediments near Kiama indicate that there were glaciers on the Australian coast during the Permian.

Pollens and sediments provide a useful clue to the ancient climate and by linking these together, they provide a solid base of evidence to relate to variations in temperature from the ancient past.

Question 28 (a)

| Criteria | Marks |
|---|-------|
| <ul style="list-style-type: none"> Identifies that tilt increases prior to an eruption and/or decreases as a result of an eruption | 1 |

Sample answer:

Eruptions on Kilauea follow an increase in the tilt of the summit.

Or

Tilt of the summit decreases after an eruption begins on Kilauea.

Question 28 (b)

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Provides information about tectonic earthquake activity OR historical data and eruptions | 2 |
| <ul style="list-style-type: none"> Identifies earthquakes or historical data as an indicator | 1 |

Sample answer:

Graph 2 shows that an increase in frequency of tectonic earthquakes can predict an impending eruption.

Answers could include:

The graph indicates that an eruption occurs every month.

Question 28 (c)

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Demonstrates an understanding of the nature of historical data in predicting eruptions Describes the importance of providing reliable timely predictions Provides a judgement regarding the importance of predictions | 4 |
| <ul style="list-style-type: none"> Identifies historical data of past behaviour can be used to predict future behaviour of volcanoes Identifies the importance of providing reliable predictions Provides a judgement regarding the importance of predictions | 3 |
| <ul style="list-style-type: none"> Identifies the importance of making reliable predictions of eruptions | 2 |
| <ul style="list-style-type: none"> Provides some relevant information about making predictions of an eruption | 1 |

Sample answer:

Historical data which shows repeating patterns of behaviour such as that seen in both graphs, where eruptions occur following a period of increased tilt and earthquake activity, provides valuable information that a volcano is preparing to erupt. This improves the reliability of predictions allowing scientists to provide sufficient warning to local communities to evacuate the region before the eruption occurs. While this may not reduce the damage caused by the eruption, it is possible to save many lives.

Question 29 (a)

| Criteria | Marks |
|--|-------|
| • Completes the table correctly | 3 |
| • Completes two of the required sections | 2 |
| • Provides some relevant information | 1 |

Sample answer:

| | MAGMA | | |
|---------------------------|-------------------|------------------------------------|--|
| | MAFIC | INTERMEDIATE | FELSIC |
| Minerals present | Olivine, pyroxene | Pyroxene, amphibole, biotite mica | <i>Potassium feldspar, biotite mica and quartz</i> |
| Source of minerals | <i>Mantle</i> | Upper mantle and continental crust | Continental crust |
| Tectonic setting | Mid-ocean ridge | <i>Subduction zone</i> | Continental hot spot |

Answers could include:

Tectonic setting could also include Ocean–Ocean or Ocean–Continent Convergence.

Question 29 (b)

| Criteria | Marks |
|--|-------|
| • Demonstrates a thorough knowledge and understanding of the process of progressive crystallisation • Uses information from both diagrams | 4 |
| • Demonstrates a sound knowledge and understanding of the process of progressive crystallisation • Uses information from diagram(s) | 3 |
| • Outlines the difference in the mineral composition of Magma X and Magma Z | 2 |
| • Provides some relevant information about crystallisation or mineral composition | 1 |

Sample answer:

Magma X is much hotter than Magma Z and the only minerals able to crystallise at these high temperatures are olivine, pyroxene and calcium rich plagioclase. Since Magma Z is so much cooler, these minerals have already crystallised out of the magma mix and the only components remaining in Magma Z will produce biotite mica, plagioclase feldspar and quartz.

Question 30 (a)

| Criteria | Marks |
|--|-------|
| • Orders all SIX letters in the correct order beginning with D | 2 |
| • Orders any THREE letters correctly | 1 |

Sample answer:

D (starts break-up), C, E, F, A, B.

Question 30 (b)

| Criteria | Marks |
|--|-------|
| • Describes a likely/possible change to the climate or evolutionary processes that would have been altered by the formation of the Isthmus, including details of before and after the formation of the Isthmus | 3 |
| • Identifies a characteristic of the climate or evolutionary processes that would have been altered by the formation of the Isthmus | 2 |
| • Provides some relevant information on climate or evolutionary processes or geological processes | 1 |

Sample answer:*Climate*

Prior to the formation of the Isthmus, the waters of the Pacific and Atlantic Oceans would have been able to mix, and equatorial waters would have been kept warm. Once the Isthmus formed, they could no longer mix. This would have affected the direction of the water currents and their saltiness which would have changed the distribution of heat around the planet.

OR

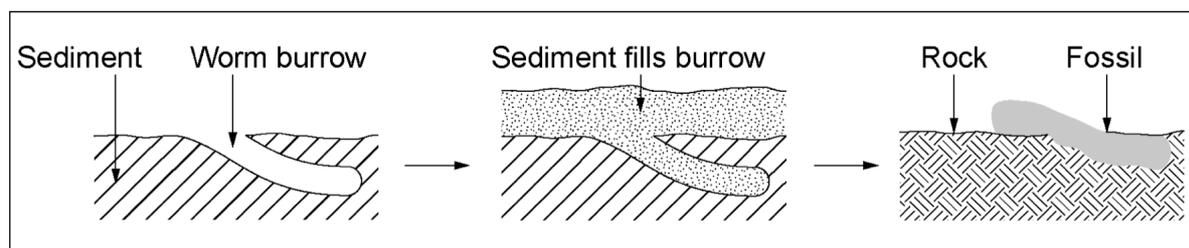
Evolutionary processes

Previous to the Isthmus forming, the organisms on North and South America would have evolved separately, and have been physically separated. Once the landmasses joined, species from one continent could now migrate to the other continent, resulting in predation competition or interbreeding.

Question 31 (a)

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Draws THREE cross-sectional diagrams in correct sequence with labels | 3 |
| <ul style="list-style-type: none"> Draws THREE relevant labelled diagrams OR <ul style="list-style-type: none"> Draws TWO labelled cross-sectional diagrams showing part of the sequence | 2 |
| <ul style="list-style-type: none"> Draws ONE relevant diagram OR <ul style="list-style-type: none"> Provides some relevant information | 1 |

Sample answer:



Question 31 (b) (i)

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Describes how both relative and absolute dating can be used to give an accurate date for <i>Treptichnus pedum</i> (Tp) Demonstrates clear understanding of radiometric dating and superposition | 3 |
| <ul style="list-style-type: none"> Describes how either relative or absolute dating is used to date Tp OR <ul style="list-style-type: none"> Identifies that relative and absolute dating are both used to date Tp | 2 |
| <ul style="list-style-type: none"> Provides some relevant information about the sequence or age | 1 |

Sample answer:

Relative dating will also tell us that Tp is younger than Dickinsonia and Cloudina because it is above them and older than the layer containing the trilobite because it is below it. A more accurate age can be determined using a combination of radiometric dating to determine an absolute age for the igneous rocks and the relative position of the fossil between them. The *Treptichnus pedum* (Tp) would therefore be dated between 505 Ma BP and 620 Ma BP.

Question 31 (b) (ii)

| Criteria | Marks |
|--|-------|
| <ul style="list-style-type: none"> Identifies the Ediacaran–Cambrian boundary | 1 |

Sample answer:

Either Ediacaran–Cambrian Boundary, End Ediacaran or Start of the Cambrian.

Question 31 (b) (iii)

| Criteria | Marks |
|---|-------|
| <ul style="list-style-type: none"> Decides whether Tp is or is not an index fossil Provides at least two pieces of evidence taken from the question linking them to why Tp is or is not an index fossil | 4 |
| <ul style="list-style-type: none"> Links index fossils to Tp, tying in the information and linking the two, showing how Tp is or is not an index fossil | 3 |
| <ul style="list-style-type: none"> Provides some relevant information about index fossils or Tp | 2 |
| <ul style="list-style-type: none"> Provides some relevant information | 1 |

Sample answer:

Tp is an index fossil because it is only found at the beginning of the Cambrian and not before. The organism looked for food and checked for predators which is complex behaviour that was not seen before this time making it potentially a marker for the start of the Cambrian. Tp is also found worldwide which is another criterion for index fossils.

Answers could include:

A supported negative logical argument.

A response identifying logical arguments for and against.

Question 32

| Criteria | Marks |
|---|-------|
| <ul style="list-style-type: none"> Explains how TWO of the conditions found at black smokers would have been conducive to the formation of organic molecules | 3 |
| <ul style="list-style-type: none"> Provides information about black smokers and the conditions needed for the formation of basic organic molecules | 2 |
| <ul style="list-style-type: none"> Provides some relevant information about the conditions or organic molecules | 1 |

Sample answer:

Chemicals are leached from the rocks around the 'Black Smokers' as water percolates through the hot rocks. These chemicals could have been used to form the basic molecules, such as amino acids. The superheated water provides the energy for the reactions to occur. Pyrite, which is found in this environment, could have provided a template for the formation of organic molecules.

Question 33

| Criteria | Marks |
|---|-------|
| <ul style="list-style-type: none"> • Demonstrates an extensive knowledge and understanding of mass extinctions and the effect of human activities on the planet • Relates current activities to the possibility of a mass extinction • Demonstrates a clear analysis of the statement • Constructs a logical and coherent response leading to a reasoned discussion of implications contained in at least two Modules | 8 |
| <ul style="list-style-type: none"> • Demonstrates a thorough knowledge and/or understanding of mass extinction and the effect of human activities on the planet • Relates current activities to the possibility of a mass extinction • Demonstrates an analysis of the statement | 6–7 |
| <ul style="list-style-type: none"> • Demonstrates sound knowledge and/or understanding of the effect of human activities on the planet • Provides (or attempts to provide) links to extinction • Makes a reasoned argument for the possibility of the statement | 4–5 |
| <ul style="list-style-type: none"> • Describes features of an extinction event and/or relates these to current human activities <p>OR</p> <ul style="list-style-type: none"> • Provides relevant information on human activities and/or mass extinction | 2–3 |
| <ul style="list-style-type: none"> • Provides relevant information | 1 |

Answers could include:

A clear analysis of the implications of the statement

- Why only ‘some’ scientists?
- ‘Predicting’ on what evidence?

Mass extinction causes and examples from the past

- Are current rates of extinction of the level required?

At least two Modules referenced.

Human impacts on the atmosphere, biosphere and hydrosphere

- Earth Processes
- Climate Science

Human impacts on species and their habitat

- Hazards (bushfires)

Unprecedented rates of decline in Species

- Resource Management (Sustainability)

Linking of the components and identification of the implications.

Judgement of possibility of statement coming to pass.

2021 HSC Earth and Environmental Science Mapping Grid

Section I

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

Section II

| Question | Marks | Content | Syllabus outcomes |
|----------|-------|---|----------------------------|
| 21 | 4 | Waste Management | EES12-15 |
| 22 (a) | 1 | Using Australia's Natural Resources | EES12-15 |
| 22 (b) | 3 | Using Australia's Natural Resources | EES12-15 |
| 22 (c) | 3 | Using Australia's Natural Resources | EES12-15 |
| 23 | 4 | Geological Natural Disasters | EES12-13 |
| 24 | 4 | Mitigation and Adaptation Strategies | EES12-4, EES12-14 |
| 25 | 7 | Sustainability | EES12-7, EES12-15 |
| 26 (a) | 4 | Natural Processes of Variations in Climate | EES12-4, EES12-14 |
| 26 (b) | 4 | Influence of Human Activities on Changes to Climate | EES12-7, EES12-14 |
| 27 | 5 | Evidence for Climate Variation | EES12-14 |
| 28 (a) | 1 | Predication and Prevention of Natural Disasters | EES12-4, EES12-5, EES12-13 |
| 28 (b) | 2 | Predication and Prevention of Natural Disasters | EES12-4, EES12-5, EES12-13 |

| Question | Marks | Content | Syllabus outcomes |
|-----------------|--------------|--|--|
| 28 (c) | 4 | Predication and Prevention of Natural Disasters | EES12-6, EES12-5, EES12-13 |
| 29 (a) | 3 | Geological Natural Disasters | EES12-4, EES12-13 |
| 29 (b) | 4 | Geological Natural Disasters | EES12-4, EES12-5, EES12-6, EES12-13 |
| 30 (a) | 2 | Plate Tectonic Supercycle | EES12-4, EES12-6, EES12-12 |
| 30 (b) | 3 | Plate Tectonic Supercycle | EES12-6, EES12-12 |
| 31 (a) | 3 | Fossil Formation and Stratigraphy | EES12-4, EES12-6, EES12-12 |
| 31 (b) (i) | 3 | Fossil Formation and Stratigraphy | EES12-5, EES12-6, EES12-12 |
| 31 (b) (ii) | 1 | Fossil Formation and Stratigraphy | EES12-4, EES12-12 |
| 31 (b) (iii) | 4 | Fossil Formation and Stratigraphy | EES12-5, EES12-6, EES12-12 |
| 32 | 3 | Development of the Biosphere | EES12-12 |
| 33 | 8 | Earth's Processes Hazards Climate Science Resource Management | EES12-6, EES12-12, EES12-13 EES12-7, EES12-14 EES12-15 |