2023 HSC Earth and Environmental Science Marking Guidelines

Section I

Multiple-choice Answer Key

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

Section II

Question 21

Criteria	Marks
• Outlines conditions that would classify an east coast low as a disaster	2
• Provides some relevant information	1

Sample answer:

The east coast low needs to produce enough rainfall to cause significant damage to property and major disruption to the people living in affected areas.

Question 22

Criteria	Marks
• Outlines an effect of photosynthesis on the development of the geosphere and the atmosphere	3
• Identifies an effect of photosynthesis on each sphere OR • Outlines an effect of photosynthesis on one sphere	2
• Provides some relevant information	1

Sample answer:

Sphere	*Effect of photosynthesis*
Geosphere	Oxygen from photosynthesis reacted with dissolved iron, forming iron oxide, creating banded iron formations.
Atmosphere	Carbon dioxide is converted into free oxygen during photosynthesis which changed the composition of the atmosphere. Carbon dioxide levels were reduced, and oxygen levels increased.

Answers could include:

Ozone formation

Question 23

Criteria	Marks
• Provides the missing components in the table	3
• Provides TWO of the missing components in the table	2
• Provides some relevant information	1

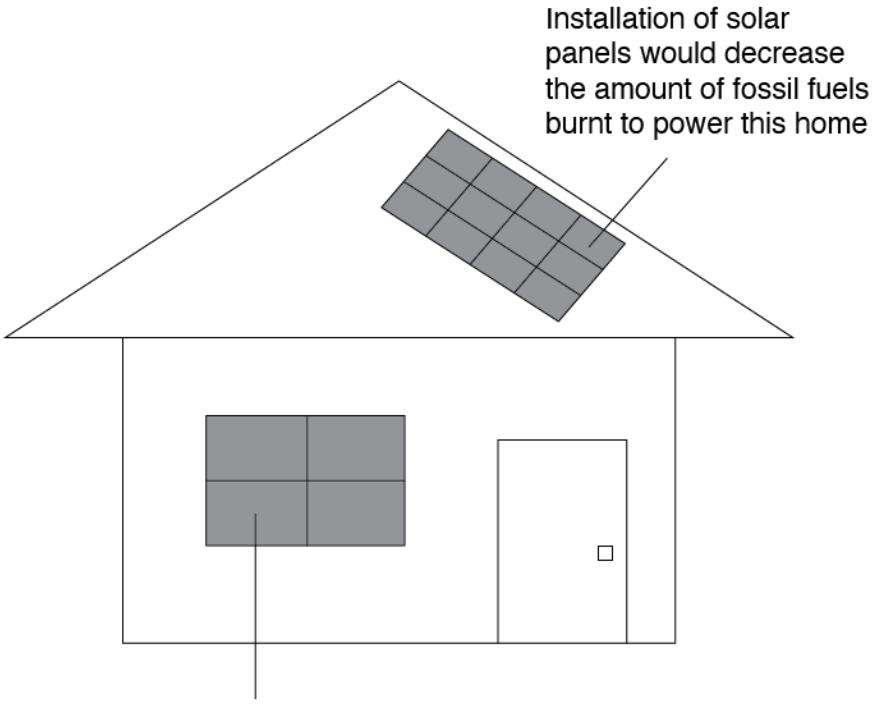
Sample answer:

	Natural greenhouse effect	*Anthropogenic greenhouse effect*
Definition	Gases in the Earth's atmosphere trap the Sun's heat	*An increase in warming of Earth's atmosphere due to increased greenhouse gases released from human activity*
One greenhouse gas source	*Volcanic eruptions*	Carbon dioxide from burning fossil fuels
Timescale over which it occurs	Continuous over Earth's evolution	*Since the Industrial Revolution (mid 1700's)*

Question 24

Criteria	Marks
• Justifies TWO design modifications by annotations	3
• Justifies ONE design modification by annotations OR • Identifies TWO design modifications	2
• Provides some relevant information	1

Sample answer:



Question 25 (a)

Criteria	Marks
• Provides a clear definition of sustainability, including a relevant example	2
• Defines sustainability OR • Provides some relevant information	1

Sample answer:

Sustainability is the management of a resource in a manner that allows for long term, continuous use. For example, plantation timber forestry will provide long term timber.

Question 25 (b)

Criteria	Marks
• Justifies a suitable strategy for collecting information	2
• Outlines a valid strategy for gathering relevant information	1

Sample answer:

For an initiative developed by a local council, the council's website should be consulted. Council employees involved in the initiative are likely to have direct input into the website resulting in accurate information.

Question 26

Criteria	Marks
• Identifies a resource as renewable or non-renewable • Provides a relevant extraction or management strategy for improvement and provides a sustainability-related reason in favour of the strategy	3
• Provides a relevant extraction or management strategy • Provides a sustainability-related reason in favour of the strategy OR identifies a resource as renewable or non-renewable	2
• Identifies a resource as renewable or non-renewable • OR • Outlines a sustainable extraction or management strategy	1

Sample answer:

Resource: Water (renewable)

Water can be extracted from rivers by pumping to nearby farms for irrigation. Farmers should manage water by using the minimum necessary for irrigation, thus keeping water tables and salt deep in the ground, enabling long-term water use. Excessive irrigation can raise water tables bringing salt to the surface, harming crops and making farming unsustainable.

Question 27 (a)

Criteria	Marks
• Names a type of trace fossil	1

Sample answer:

Burrows

Answers could include:

Footprints, tracks, trails

Question 27 (b)

Criteria	Marks
• Provides similarities and differences between Ediacaran and Cambrian ecosystems	3
• Provides ONE similarity and ONE difference between the ecosystems	2
• Provides some relevant information	1

Sample answer:

Similarities:
- Both ecosystems had soft bodied organisms present
- Both ecosystems had attached, burrowing and swimming movement.

Differences:
- The Ediacaran only had soft bodied organisms whilst the Cambrian had soft and hard body parts
- The Cambrian had walking and carnivorous organisms while the Ediacaran did not.

Answers could include:

- Both were marine ecosystems
- Most organisms in both ecosystems are extinct
- The Cambrian had predation
- The Cambrian ecosystem had more complex interactions than the Ediacaran
- Cambrian organisms were more diverse than Ediacaran organisms.

Question 27 (c)

Criteria	Marks
• Explains how relative dating can be used to determine the age of fossilised organisms	3
• Describes a relative dating technique	2
• Provides some relevant information	1

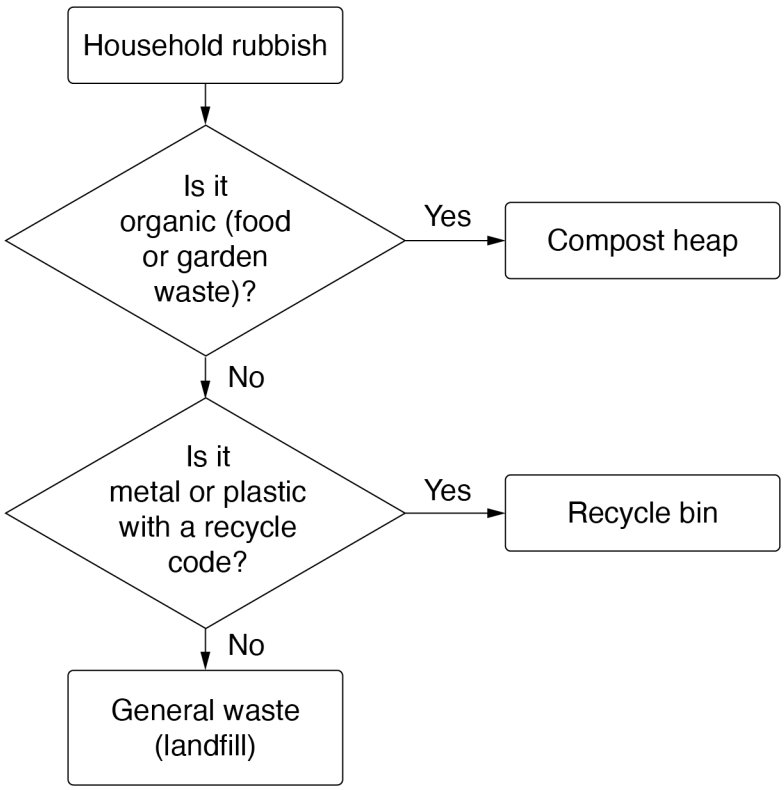
Sample answer:

Relative dating uses techniques, such as the Law of Superposition, where older layers of rock are found under younger layers in an undisturbed sequence. This allows scientists to place fossils in order from younger to older and sequence them in the geological timescale.

Question 28

Criteria	Marks
• Provides a clearly-sequenced flow chart • Links THREE different waste types to sustainable management strategies	4
• Provides a flow chart • Links TWO waste types to sustainable management strategies	3
• Links ONE waste type to a suitable management strategy	2
• Prepares a flow chart OR • Identifies a waste management strategy OR • Identifies THREE waste types	1

Sample answer:



Question 29 (a)

Criteria	Marks
• Demonstrates a sound understanding of how the Urey–Miller experiment provides evidence for the origin of organic molecules • Includes reference to TWO components of the diagram	3
• Demonstrates some understanding of how the Urey–Miller experiment provides evidence for the origin of organic molecules	2
• Provides some relevant information	1

Sample answer:

The Urey–Miller experiment recreated the conditions thought to exist on early Earth. The chamber contained gases thought to be in the Earth's early atmosphere, the electrodes represent lightning, the condenser represents rain and the trap models the oceans. The results showed that amino acids formed, providing evidence that organic molecules could form from non-organic gases in the right conditions.

Question 29 (b)

Criteria	Marks
• Demonstrates a thorough knowledge of the usefulness of the Plate Tectonic Supercycle model using the given criteria • Provides a supported judgement	5
• Demonstrates a sound knowledge of the usefulness of the Plate Tectonic Supercycle model using some of the given criteria • Provides a supported judgement	4
• Demonstrates some knowledge of the usefulness of the Plate Tectonic Supercycle model and provides a judgement	3
• Demonstrates some knowledge of the Plate Tectonic Supercycle model or addresses a criterion	2
• Provides some relevant information	1

Sample answer:

The Plate Tectonic Supercycle (PTSC) can be modelled using playdough and creating a stop motion video to show the different stages of the PTSC including the formation and breakup of supercontinents. It is highly useful as a model as it helps explain what happens when two plates collide and the key features that are created at different plate boundaries. It can also assist in solving problems by enabling geologists to visualise the movement of tectonic plates and potential locations of earthquakes. However, it less useful for predictions because playdough doesn't behave the same as rocks.

Question 30 (a)

Criteria	Marks
• Identifies the independent and dependent variables	1

Sample answer:

Independent variable – pH level
Dependent variable – Change in mass of shell

Question 30 (b)

Criteria	Marks
• Calculates change in mass and percentage difference for pH 6 and pH 3	2
• Provides some relevant information	1

Sample answer:

pH level	*Shell mass before* (g)	*Shell mass after* (g)	*Change in mass* (g)	*Percentage difference* (%)
8	32.1	32.5	+0.4	+1.2
6	25.0	23.9	**–1.1**	**–4.4**
3	26.8	22.7	**–4.1**	**–15.3**

Question 30 (c)

Criteria	Marks
• Justifies a conclusion for the investigation	2
• Provides some relevant information	1

Sample answer:

A decrease in pH (which models increasing ocean acidity) lowers the mass of the shell as stated in the hypothesis. This is seen by the results which show a greater percentage loss of mass as pH level lowers from 8 to 3.

Question 31

Criteria	Marks
• Describes in detail the involvement of traditional owners in mine planning, practices and restoration • Identifies explicit criteria for the evaluation of mine planning, practice and restoration • Refers to a relevant case study or a specific example • Provides a well-supported judgement	7
• Describes in some detail the involvement of traditional owners in mine planning, practices and restoration • Identifies relevant criteria for the evaluation of mine planning, practice and restoration • Refers to a relevant case study or specific example • Provides a judgement	6
• Describes the involvement of traditional owners in mine planning, practices and restoration • Identifies or infers criteria for the evaluation of mine planning, practice and/or restoration • Refers to a relevant case study or example • Provides or infers a judgement	4–5
• Outlines the involvement of traditional owners in mine planning, practice or restoration AND/OR • Identifies or infers criteria for evaluation of mine planning, practice or restoration	2–3
• Provides some relevant information	1

Answers could include:

Criterion 1: Protection of cultural sites

Consultation with traditional owners during the exploration of new mining areas allows important cultural sites to be identified and protected, for example, the Northparkes Copper Mine regularly engages with the Wiradjuri Executive Committee (WEC) who review site disturbance plans and advise the miners as to which areas should be avoided when mining or constructing infrastructure, thus effectively protecting cultural sites such as scarred trees.

Criterion 2: Community employment

Mining companies can work with Aboriginal communities by offering relevant training and recruiting within the community for mine workers. This benefits the mining operation by providing a skilled local workforce and benefits the local community by increasing employment opportunities. For example, Northparkes works through the WEC to offer scholarships and recruit local Aboriginal employees.

Criterion 3: Waterway protection

When restoring tailings dumps, topsoil is spread over the tailings and plants are used to stabilise the soil. Local traditional owners are well connected to Country and have relevant expertise to advise on suitable species to plant. Wise species choices will improve the stability of the new ecosystem, protecting soils and effectively preventing tailings from escaping into local waterways. The WEC would have been consulted when Northparkes recently decommissioned a tailings dam.

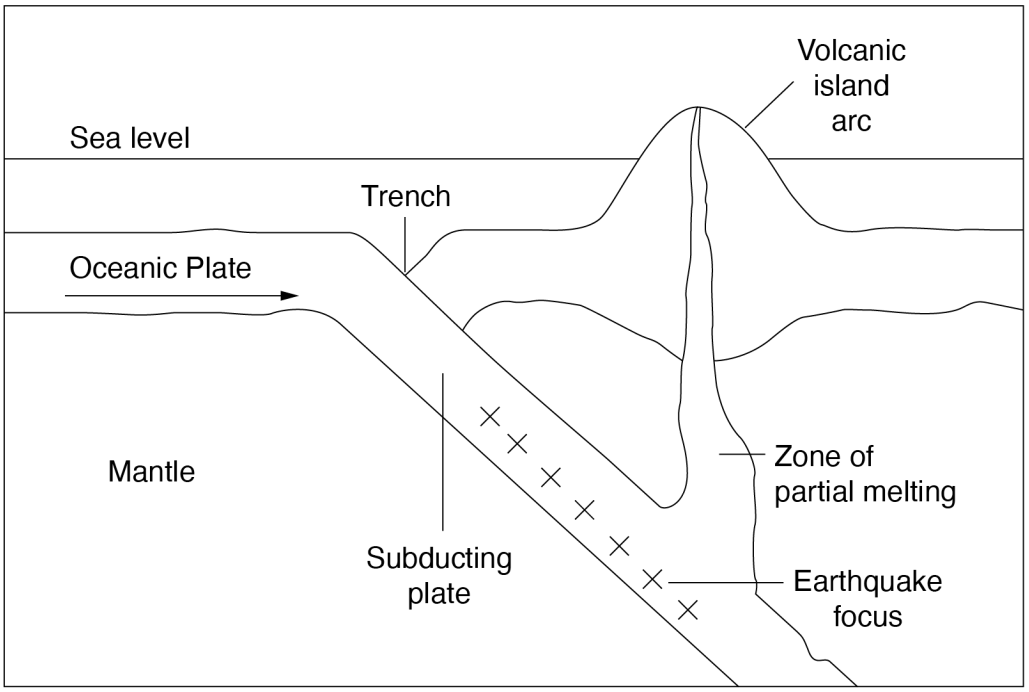
Judgement:

Involving traditional owners in mine planning, operation and rehabilitation has substantial benefits for both mining companies and Aboriginal communities.

Question 32 (a)

Criteria	Marks
• Draws a clearly-labelled cross-section showing key tectonic and topographical features	3
• Draws a partially correct cross-section showing some tectonic and/or topographical features	2
• Show some relevant features	1

Sample answer:



Question 32 (b)

Criteria	Marks
• Describes a technology that could be used to understand a characteristic of the earthquake	2
• Provides some relevant information	1

Sample answer:

A seismometer could be used to determine the magnitude of the earthquake. This technology measures and records the movement of Earth's crust at the seismometer's location.

Answers could include:

Ocean buoys, GPS stations

Question 33 (a)

Criteria	Marks
• Names TWO hazards caused by the eruption and provides characteristics/features of each	3
• Provides the characteristics of ONE hazard	2
• Provides some relevant information	1

Sample answer:

Enormous pyroclastic flows – fast moving clouds of hot gases and ash came down the sides of the mountain, destroying everything in their path.

Lahars – flowing rivers of mud (with a wet concrete-like consistency) continued for years with large rainfall events, as the ash washed down the sides of the mountain.

Question 33 (b)

Criteria	Marks
• Describes an effect of the 1991 eruption on the natural environment surrounding the volcano • Makes a judgement about the impact of the eruption	3
• Identifies an effect of the 1991 eruption on a natural environment OR • Infers a judgement about the impact of the eruption on a natural environment	2
• Provides some relevant information	1

Sample answer:

The ash covered the ground and the plants themselves, preventing the growth of plants in the area around the volcano. Ash also mixed with water in streams causing lahars which blocked water sources and made them muddy and impure. This was devastating for local ecosystems.

Question 33 (c)

Criteria	Marks
• Account for the explosivity of the eruption	4
• Outlines TWO reasons why the eruption is explosive	3
• Identifies TWO reasons why the eruption is explosive OR • Outlines ONE reason	2
• Provides some relevant information	1

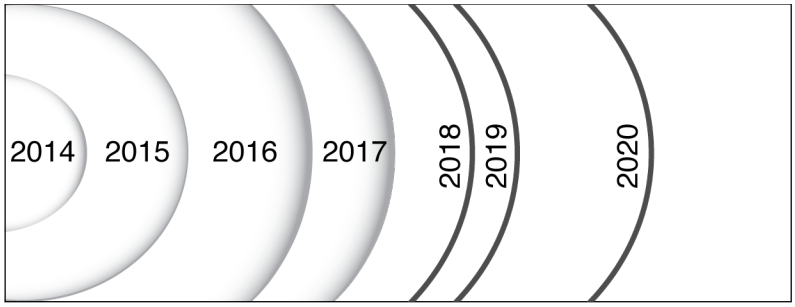
Sample answer:

The magma at Mt Pinatubo is formed by the partial melting of the subducting oceanic plate. This material is very viscous and makes a very gas-rich, hot and silica-rich felsic magma. When it erupts from the volcano, it does so very explosively as the gases escape, usually as a pyroclastic flow, tephra, ash or causing subsequent lahars, rather than as a lava flow.

Question 34 (a)

Criteria	Marks
• Draws THREE rings proportional to growth	2
• Provides some relevant information	1

Sample answer:



Question 34 (b)

Criteria	Marks
• Demonstrates extensive knowledge and understanding of dendrochronology and changes in rock types as evidence of past variations in global temperature • Provides advantages and/or limitations of dendrochronology and changes in rock types as evidence of past variations in global temperature	6
• Demonstrates thorough knowledge and understanding of dendrochronology and changes in rock types as evidence of past variations in global temperature • Provides an advantage or limitation of dendrochronology and changes in rock types as evidence of past variations in global temperature	5
• Demonstrates sound knowledge and understanding of dendrochronology and/or changes in rock type as evidence of past variations in temperature • Provides an advantage or limitation of dendrochronology or changes in rock type as evidence of past variations in temperature	3–4
• Outlines dendrochronology or changes in rock type as evidence of past variations in temperature	2
• Provides some relevant information	1

Sample answer:

Dendrochronology is the study of past climates by using tree rings. The size of the annual tree ring can be linked to the conditions of its growth in a local area but limited to the lifetime of the tree. For example, a smaller ring than normal may indicate cooler conditions in a given year. However, the validity of these data is affected by other factors, such as rainfall. Tree rings are also limited to indicating local weather rather than global temperature variations.

Changes in rock types provide evidence for ancient global temperature variation over a longer time frame than tree rings. For example, coal deposits in strata indicate the presence of a warm, swampy environment. This again is limited to the local area. However, the presence of glacial tillite indicates cooler climates, and depending on location, may suggest global cooling.

Question 35

Criteria	Marks
• Demonstrates an extensive knowledge and understanding of natural processes and human influences relating to the two images • Integrates relevant examples from at least TWO modules	8
• Demonstrates a thorough knowledge and understanding of natural processes and human influences relating to the two images • Integrates relevant examples from the modules	6–7
• Demonstrates a sound knowledge and/or understanding of natural processes and/or human influences relating to the two images • Identifies relevant examples	4–5
• Demonstrates some understanding of natural processes and/or human influences	2–3
• Provides some relevant information	1

Answers could include:

Figure 1 can clearly be linked to plate tectonics and the resulting climate change related to the current position of the continents and the resulting ocean currents around the planet. This has a clear impact on the climate and the resulting distribution of vegetation around the world. This can be seen in such cases where a cold ocean current along the west coast of South America influences the desert environment in Chile.

Natural Processes include:

- Plate Tectonics
- Plate tectonic supercycle
- Water distribution
- Resource distribution
- Climate
- Processes shaping topography.

Figure 2 shows the artificial light caused by human population distribution and resource management. This can then be related to energy demand and using Figure 1 it also shows the resulting environmental impact and potential habitat destruction due to human dominance and modification of the environment. Despite the potential impact of such hazards as tsunamis and weather patterns (East coast lows) that have resulted from the continental distribution, it is clear from the light distribution that many humans choose to live on the coast of many continents or islands such as Indonesia.

Human Influences include:

- Population distribution
- Land use patterns
- Energy demand
- Environmental impact
- Habitat removal
- Resource use and waste production
- Distortion of continental shape due to map projection.

2023 HSC Earth and Environmental Science Mapping Grid

Section I

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

Section II

Question	Marks	Content	Syllabus outcomes
21	2	Mod 6 Geological Natural Disasters	12-13
22	3	Mod 5 Changes in the Geosphere, Atmosphere and Hydrosphere	12-12
23	3	Mod 7 Influence of Human Activities on Changes to Climate	12-14
24	3	Mod 7 Mitigation and Adaptation Strategies	12-14
25 (a)	2	Mod 8 Sustainability	12-15
25 (b)	2	Mod 8 Sustainability	12-15
26	3	Mod 8 Using Australia's Natural Resources	12-15
27 (a)	1	Mod 5 Fossil Formation and Stratigraphy	12-12
27 (b)	3	Mod 5 Development of the Biosphere	12-12, 12–5
27 (c)	3	Mod 5 Fossil Formation and Stratigraphy	12-12
28	4	Mod 8 Waste Management	12-7, 12-15

Question	Marks	Content	Syllabus outcomes
29 (a)	3	Mod 5 Development of the Biosphere	12-12
29 (b)	5	Mod 5 Plate Tectonic Supercycle	12-6, 12-12
30 (a)	1	Mod 7 Influence of Human Activities on Changes to Climate	12-2, 12–14
30 (b)	2	Mod 7 Influence of Human Activities on Changes to Climate	12-4, 12–14
30 (c)	2	Mod 7 Influence of Human Activities on Changes to Climate	12-7, 12-14
31	7	Mod 8 Using Australia's Natural Resources	12-7, 12-15
32 (a)	3	Mod 6 Geological Natural Disasters	12-6, 12-7, 12-13
32 (b)	2	Mod 6 Prediction and Prevention of Natural Disasters	12-13
33 (a)	3	Mod 6 Impact of Natural Disasters on the Biosphere	12-13
33 (b)	3	Mod 6 Impact of Natural Disasters on the Biosphere	12-13
33 (c)	4	Mod 6 Geological Natural Disasters	12-13
34 (a)	2	Mod 7 Evidence for Climate Variation	12-6, 12-14
34 (b)	6	Mod 7 Evidence for Climate Variation	12-14
35	8	All Modules	12-7, 12-12, 12-13, 12-14, 12-15