Earth & Environmental Science marking guide and response

External assessment 2021

Combination response (113 marks)

Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

1. describe and explain the use of renewable and non-renewable resources and the cause and impact of Earth hazards and global climate change
2. apply understanding of use of renewable and non-renewable resources and the cause and impact of Earth hazards and global climate change
3. analyse evidence about the use of renewable and non-renewable resources and the cause and impact of Earth hazards and global climate change to identify trends, patterns, relationships, limitations or uncertainty
4. interpret evidence about use of renewable and non-renewable resources and the cause and impact of Earth hazards and global climate change to draw conclusions based on analysis.

Note: Objectives 5, 6 and 7 are not assessed in this instrument.

Purpose

This document consists of a marking guide and a sample response.

The marking guide:

- provides a tool for calibrating external assessment markers to ensure reliability of results
- indicates the correlation, for each question, between mark allocation and qualities at each level of the mark range
- informs schools and students about how marks are matched to qualities in student responses.

The sample response:

- demonstrates the qualities of a high-level response
- has been annotated using the marking guide.

Mark allocation

Where a response does not meet any of the descriptors for a question or a criterion, a mark of ‘0’ will be recorded.

Where no response to a question has been made, a mark of ‘N’ will be recorded.

Marking guide

Multiple choice

Question	Response
1	C
2	B
3	C
4	A
5	C
6	C
7	D
8	C
9	A
10	B
11	C
12	A
13	C
14	D
15	A

Paper 1: Short response

Q	Sample response	The response:
16a)	The intensity of a cyclone can be identified using data, e.g. a tracking map. The intensity and/or category of cyclone can range from 1 to 5. A tracking map can also identify the area of potential damage. Gale force or strong winds are likely to damage local infrastructure and vegetation in the areas indicated.	· identifies a relevant characteristic **[1 mark]** · explains the stated characteristic **[1 mark]** · identifies a second relevant characteristic **[1 mark]** · explains the second stated characteristic **[1 mark]**
16b)	Dataset 1 is from National Park B. Stimulus 1 and 2 show that the topography (mountain range) is steeper and closer to the coast for National Park B compared to National Park A. Therefore, the cyclone will have a greater impact on B (i.e. stronger winds), which will cause greater damage to trees in contrast to National Park A. This is supported by Dataset 1. Dataset 1 in Stimulus 3 shows the most damage to trees. For example, in Dataset 1, the river red gums went from 3% damaged before to 93% damaged after, whereas in Dataset 2, they went from 1% to 52%.	· determines that Dataset 1 is from National Park B **[1 mark]** · provides evidence from Stimulus 1 to contrast National Parks A and B and justify the statement **[1 mark]** · provides evidence from Stimulus 2 to contrast National Parks A and B and justify the statement **[1 mark]** · provides evidence from Stimulus 3 to justify the statement **[1 mark]**
16c)	The species most likely to recover quickly is black wattle. This is largely due to the smaller amount of damage before and after the cyclonic event (10% before and 15% after). This contrasts with the damage sustained by weeping fig, which experienced much more damage from the cyclonic event — 2% before and 95% after.	· identifies a plant species likely to recover more quickly than others **[1 mark]** · identifies a piece of data to support the stated prediction **[1 mark]** · identifies a second piece of data to support the stated prediction **[1 mark]**

Q	Sample response	The response:
17a)	The area of the graph that the map matches is the years 2014–2015. This area is experiencing very low rainfall and is therefore undergoing drought. During 2014–2015, there was a highly negative SOI, which could result in a period of low rainfall.	· provides 2014–2015 as the years **[1 mark]** · provides drought as the condition indicated by the map at the marked location **[1 mark]** · provides highly negative SOI data as correlating with low rainfall **[1 mark]**
17b)	The largest recharge of the natural river systems would occur in 2010–2011, because there was a long period of strong La Niña conditions, which could result in prolonged rainfall events.	· provides 2010–2011 as the years **[1 mark]** · provides prolonged positive SOI data (La Niña conditions) as correlating with high rainfall **[1 mark]**
18	Much colder conditions, or even an ice age, have occurred during this time. With the colder air temperature in non-polar regions, water with a higher concentration of ^{18}O isotope would preferentially condense in the atmosphere, resulting in a greater concentration of ^{18}O isotope in the rain falling over waters where the marine species lived. The shells of marine fossils would incorporate greater proportions of heavy oxygen as the temperature drops. In Stimulus 6, the coldest locations such as Antarctica and Greenland have annual precipitation with about 5 percent less ^{18}O than ocean water. Warmer areas have higher ^{18}O than ocean water.	· draws a correct conclusion **[1 mark]** · justifies the stated conclusion with a piece of evidence **[1 mark]** · justifies the stated conclusion with a second piece of evidence **[1 mark]**

Q	Sample response	The response:
19	Soil sampling: Involves collecting sieved or auger soil for analysis. Soil samples are collected from a widely spaced grid and analysed for mineral location and concentrations. Sediment analysis: Involves collecting sediments along a water course for analysis to determine target source of the mineral.	· identifies a geochemical technique **[1 mark]** · describes the identified technique **[1 mark]** · identifies a second geochemical technique **[1 mark]** · describes the second identified technique **[1 mark]**
20	Risk: Pollution of waterways with mercury and cyanide from tailing dams Strategy: Adjust processes to avoid contamination, e.g. using extraction methods that are environmentally friendly and do not produce toxins Principle behind strategy: There is no opportunity for toxin release into the environment Risk: Habitat destruction — gold mining involves moving massive amounts of earth, detrimental to wildlife habitat Strategy: Create a plan for species protection while mining and a plan for post-mining remediation Principle behind strategy: Environmental protection through pre-mining agreements with monitoring and heavy fines for breaches	· identifies a risk **[1 mark]** · proposes a strategy to mitigate the risk **[1 mark]** · explains the principle behind the strategy **[1 mark]** · identifies a second risk **[1 mark]** · proposes a strategy to mitigate the second risk **[1 mark]** · explains the principle behind the second strategy **[1 mark]**

Q	Sample response	The response:
21	The coal seam is located between –105.5 m and –109.5 m depth and has a thickness of 4 m. Coal has a significantly lower density than the associated sedimentary rocks.	· determines that the coal seam occurs between the depth of –105.5 m and –109.5 m **[1 mark]** · identifies a thickness of 4 m **[1 mark]** · provides a reason **[1 mark]**
22	Mangroves store carbon as biomass and through burial of organic matter, though some carbon is released as a waste product of cellular respiration. If a mangrove ecosystem is cleared, cellular respiration continues to release carbon dioxide, but storage of carbon stops, as photosynthesis stops when the plant dies. Buried carbon remains stored but is not contributed to after mangrove removal. The mangrove ecosystem removes more carbon dioxide from the atmosphere from photosynthesis than it releases through cellular respiration. This is due to the conversion to and storage of glucose ($C_6H_{12}O_6$). The anaerobic respiration necessary in the anoxic silt of mangrove ecosystems produces the additional greenhouse gas of methane. Methane is a more potent greenhouse gas than carbon dioxide but is less abundant and therefore contributes less to overall greenhouse effect and global warming.	· explains that mangroves store carbon through accumulation of biomass **[1 mark]** · identifies that mangroves contribute to the storage of carbon through burial of organic matter **[1 mark]** · identifies that mangroves contribute to the release of carbon dioxide through cellular respiration **[1 mark]** · identifies that carbon storage would cease once a mangrove is cleared **[1 mark]** · identifies the importance of the photosynthetic process for removing (i.e. storing) carbon dioxide from the atmosphere **[1 mark]** · explains that the mangrove ecosystem contributes to the release of carbon in the form of methane **[1 mark]** · identifies that anaerobic respiration would continue to occur during the clearing phase **[1 mark]**

Q	Sample response	The response:
23	Mitigation strategies for the chosen site: · using building standards that can withstand earthquakes and tsunamis. Ground motion from seismic activity can still occur, even with a lower probability · building structures, such as sea walls, to reduce the energy of tsunamis before they reach the new development · installing a tsunami and earthquake early warning system. Early warning systems enable people to properly prepare for any imminent earthquake or tsunami.	· identifies a mitigation strategy **[1 mark]** · provides a reason for the identified strategy **[1 mark]** · identifies a second mitigation strategy **[1 mark]** · provides a reason for the second identified strategy **[1 mark]** · identifies a third mitigation strategy **[1 mark]** · provides a reason for the third identified strategy **[1 mark]**

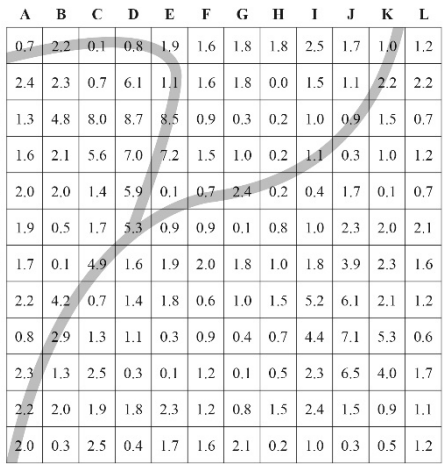
Paper 2: Short response

Q	Sample response	The response:
1a)	Milling uses heavy balls in a rotating drum to break the mineral grains away from the gangue grains and reduce the size of these grains to expose more surface area for further processing steps. An example would be gold extracted from gold ore.	· describes milling **[1 mark]** · identifies an ore extracted by milling **[1 mark]** · identifies a mineral extracted by milling **[1 mark]**
1b)	Sluicing uses a slurry of ore minerals over a shaking table to separate heavier ore minerals from the lighter gangue grains. An example would be zircon extracted from mineral sands.	· describes sluicing **[1 mark]** · identifies an ore extracted by sluicing **[1 mark]** · identifies a mineral extracted by sluicing **[1 mark]**
2a)	*Biosphere* Clearing of native ecosystem for mine site leads to reduction in species biodiversity or abundance. This is monitored by completing distribution or abundance surveys of local wildlife.	· identifies an impact on the biosphere **[1 mark]** · proposes a method for monitoring the impact on the biosphere **[1 mark]**
2b)	*Hydrosphere* Mine water discharged to a stream can contain pollutants, such as acid mine drainage, metal contamination and increased sediment levels in streams. This is monitored by testing water pH, dissolved oxygen and turbidity in the discharged water.	· identifies an impact on the hydrosphere **[1 mark]** · proposes a method for monitoring the impact on the hydrosphere **[1 mark]**

Q	Sample response	The response:
3	Over the course of the whole year, the mine has successfully managed sulfur dioxide levels, as at each of the four monitoring stations, the average annual sulfur dioxide levels are lower than the 20 µg/m^3/day national air quality standard. On 10 July 2020, there was a sulfur dioxide level of 91 µg/m^3 recorded at the mine site, which exceeds the 80 µg/m^3 daily limit. This shows that the management strategy has not been completely successful, as there are individual occasions where the daily limit is exceeded. However, on average for the entire year, the sulfur dioxide levels are managed appropriately. Limitations of data include the limited range of daily data (only three days over a five-day period), which is not an accurate representation to comment on daily management of SO_2. Another limitation is environmental factors, e.g. wind, which may also be having an effect, as no additional SO_2 management by the mine has occurred and yet the monitored values have decreased.	· draws the conclusion that the mine has successfully managed sulfur dioxide levels **[1 mark]** · justifies the stated conclusion using a piece of evidence **[1 mark]** · justifies the stated conclusion using a second piece of evidence **[1 mark]** · justifies the stated conclusion using a third piece of evidence **[1 mark]** · identifies a limitation in the data **[1 mark]** · identifies a second limitation in the data **[1 mark]**

Q	Sample response	The response:
4	**Average ground levels (metres above sea level)** The ground around a volcano swells as the magma moves towards the volcano, making average ground level a good predictor of a volcanic eruption. The data shows the ground gradually swelling before the volcanic event in July 2020. The average ground level in April was 1.27 m, rose to 1.34 m on the date of the eruption, and dropped substantially afterwards, indicating a possible eruption and release of underground pressure. **Frequency of minor earthquakes (earthquakes/month)** An increase in the frequency of earthquakes can signal a volcanic event. After July 2020, there were fewer earthquakes. However, the data in the table is variable, and does not indicate that the volcano is about to erupt. There is no clear increasing trend in the number of minor earthquakes happening before July 2020, i.e. April–July. **Level of toxic gases** The level of toxic gases increases before the indicated volcanic event, i.e. from moderate level of toxic gases in Jan–April up to high levels at the point of the volcanic eruption, and then back to normal after the event. Therefore, the level of toxic gases is a good predictor of a volcanic eruption.	· states the pattern before July 2020 for - average ground levels **[1 mark]** - frequency of minor earthquakes **[1 mark]** - level of toxic gases **[1 mark]** · uses data to justify the reliability of predicting volcanic eruptions from the variable - average ground levels **[1 mark]** - frequency of minor earthquakes **[1 mark]** - level of toxic gases **[1 mark]**

Q	Sample response	The response:
5a)	**Site A** Based on the evidence provided in Stimulus 3 and 4, there should be greater yields coming from summer crops due to increased rainfall during the northern wet season (October to April). Stimulus 3 shows there has been above-average rainfall in the area during the northern wet season (October to April). In Stimulus 4, summer growing crops are likely to be better adapted to increases in surface air temperature. **Site B** Based on the evidence provided in Stimulus 3 and 4, winter cereal crops and rice production will be under pressure to maintain the current level of production due to decreasing water availability and increasing surface area temperature. In Stimulus 3, there has only been average or below-average summer rainfall totals for the 20-year period recorded. This would put pressure on available water for irrigating rice. In Stimulus 4, recorded rainfall totals for winter cereal production have been below average for an extended period.	**For Site A** · determines an impact for Site A **[1 mark]** · justifies the stated impact using one piece of evidence from Stimulus 3 **[1 mark]** · justifies the stated impact using a one piece of evidence from Stimulus 4 **[1 mark]** **For Site B** · determines an impact for Site B **[1 mark]** · justifies the stated impact using one piece of evidence from Stimulus 3 **[1 mark]** · justifies the stated impact using a one piece of evidence from Stimulus 4 **[1 mark]**

Q	Sample response	The response:
5b)	A strategy to protect or enhance agricultural production for Site A could be to expand cropping activity during the summer growing season to include crops that need higher moisture requirements, e.g. cotton, sugar cane. This is required because the area has above-average rainfall deciles, so crops must be able to survive increased rainfall conditions (Stimulus 3) and higher temperatures (Stimulus 4). A strategy to protect or enhance agricultural production for Site B could be to develop and use winter cereal crop varieties that are better adapted to drier conditions. This is required because the area has below-average rainfall deciles, so crops must be able to survive drier conditions (Stimulus 3 and 4), especially in winter, and higher temperatures (Stimulus 4).	· proposes a strategy for Site A **[1 mark]** · justifies the strategy for Site A **[1 mark]** · proposes a strategy for Site B **[1 mark]** · justifies the strategy for Site B **[1 mark]**
6a)		· annotates the diagram to show a river system that follows high gold concentration values **[1 mark]**

	A	B	C	D	E	F	G	H	I	J	K	L
1	0.7	2.2	0.1	0.8	1.9	1.6	1.8	1.8	2.5	1.7	1.0	1.2
2	2.4	2.3	0.7	6.1	1.1	1.6	1.8	0.0	1.5	1.1	2.2	2.2
3	1.3	4.8	8.0	8.7	8.5	0.9	0.3	0.2	1.0	0.9	1.5	0.7
4	1.6	2.1	5.6	7.0	7.2	1.5	1.0	0.2	1.1	0.3	1.0	1.2
5	2.0	2.0	1.4	5.9	0.1	0.7	2.4	0.2	0.4	1.7	0.1	0.7
6	1.9	0.5	1.7	3.3	0.9	0.9	0.1	0.8	1.0	2.3	2.0	2.1
7	1.7	0.1	4.9	1.6	1.9	2.0	1.8	1.0	1.8	3.9	2.3	1.6
8	2.2	4.2	0.7	1.4	1.8	0.6	1.0	1.5	5.2	6.1	2.1	1.2
9	0.8	2.9	1.3	1.1	0.3	0.9	0.4	0.7	4.4	7.1	5.3	0.6
10	2.3	1.3	2.5	0.3	0.1	1.2	0.1	0.5	2.3	6.5	4.0	1.7
11	2.2	2.0	1.9	1.8	2.3	1.2	0.8	1.5	2.4	1.5	0.9	1.1
12	2.0	0.3	2.5	0.4	1.7	1.6	2.1	0.2	1.0	0.3	0.5	1.2

Q	Sample response	The response:
6b)	Coordinate D3 has been selected as a drill site due to the higher concentration of gold in the soil samples, indicating a potential gold/ore deposit. This deposit is across a large area that has strong economic potential.	· identifies an appropriate drill site **[1 mark]** · provides a reason to support the identified drill site **[1 mark]** · provides a second reason to support the identified drill site **[1 mark]**
6c)	D3 might be deemed unacceptable due to environmental run-off concerns with its proximity to the river. J9 would be an ideal drill spot as the soil sample shows gold concentrations above the background gold levels, and is further from the river, minimising environmental concerns about run-off.	· provides a reason the chosen site might be unacceptable **[1 mark]** · proposes an appropriate alternative drill site **[1 mark]** · identifies there is high gold concentration at the alternative site **[1 mark]** · provides a second reason for the alternative site **[1 mark]**
6d)	C7 contains higher gold concentration than H9–H11 due to the transport of gold along the river. The gold comes from the deposit around D3 that is close to the river and sediment has been washed downstream to settle in the area marked C7.	· provides transport by the river as a reason that gold presence is higher at C7 compared to H9–H11 **[1 mark]** · identifies the source as the ore body from D3 **[1 mark]**

Paper 2: Extended response

Q	Sample response	The response:
7a)	**Drawing a conclusion** The water management plan has been ineffective for maintaining availability of fresh water; however, it has helped to maintain the quality of the water within the local guidelines. **Reasons to support conclusions** There are below-average rainfall conditions, i.e. drought conditions. Therefore, allowing an increase in water use for crop production has not been offset by implementing restrictions on general water use due to the drought. The restrictions were implemented well into the drought and have been insufficient to support the local ecosystem, resulting in a lower availability of fresh water than would be natural.	· draws a conclusion about whether the catchment has been managed effectively that is supported by the evidence **[1 mark]** · provides a reason to support the conclusion **[1 mark]** · provides a second reason to support the conclusion **[1 mark]**
7b)	**Causes for changes in availability and quality of fresh water** Natural causes, such as the decrease in average annual rainfall totals for the area (Stimulus 5), resulted in lower availability (i.e. stream flows) and a reduction in dam storage volume (Stimulus 8). There is increased pollution caused by changed farming and urbanisation (Stimulus 7), evident from the reduced water quality shown by turbidity and dissolved oxygen levels in Stimulus 6. The level of dissolved oxygen would have been further reduced by lower flow volumes in the catchment rivers. However, the levels stay within the guidelines (Stimulus 6). The availability of water would also be affected by an increase in land use for farming and/or urbanisation (Stimulus 7), resulting in greater extraction of water.	**for identifying causes** · identifies a cause for reduced availability and quality of fresh water **[1 mark]** · identifies a second cause for reduced availability and quality of fresh water **[1 mark]** · identifies a third cause for reduced availability and quality of fresh water **[1 mark]** **for identifying impacts on the ecosystem** · identifies an impact on the ecosystem **[1 mark]** · identifies a second impact on the ecosystem **[1 mark]** · identifies a third impact on the ecosystem **[1 mark]**

Q	Sample response	The response:
	Impacts on the ecosystem Reduced availability of water for organisms can disrupt the food chain. Land clearing from increased agricultural activity can result in dryland salinity; as the water table rises, bringing salinity to the surface, it degrades soil quality for plants in the local ecosystem. Increased turbidity can affect photosynthesis of producers, disrupting the food chain. **Solution** Further water restrictions should be implemented in response to drought conditions. Having water restrictions that respond to drought conditions will enable water use when appropriate, but also ensure that there is always a minimum available for the ecosystem.	**for proposing and justifying a solution** · proposes a solution **[1 mark]** · justifies the solution **[1 mark]**