Earth & Environmental Science marking guide and response

External assessment 2022

Combination response (89 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

Paper 1: Multiple choice

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

Paper 1: Short response

Q	Sample response	The response
16a)	The mine could be viable because it lies within a sand plain.	• states the mine could be viable **[1 mark]** • justifies this prediction by stating the mine lies in a sand plain **[1 mark]**
16b)	Mineral sands occur in layers, so understanding the vertical structure of the deposit is important to assess its viability. RC drilling could verify the deposit by sampling the layers of the deposit through sampling at various depths. Many samples would be taken to assess the deposit's horizontal structure.	• identifies a plausible direct sampling technique **[1 mark]** • explains why the technique is suitable **[1 mark]**
16c)	A suitable method is open cut mining. Due to instability of the sands and their extent in layers, surface mining methods need to be used to prevent collapse.	• identifies a suitable extraction method **[1 mark]** • justifies choice of extraction method **[1 mark]**

Q	Sample response	The response
17a)	The plate is the Pacific plate.	• identifies the Pacific plate **[1 mark]**
17b)	The type of plate boundary interaction is a convergent boundary with the Kermadec Plate, subducting under the Pacific plate.	• describes the convergent plate boundary **[1 mark]**
17c)	Oceanic convergence zones often produce earthquakes that displace the sea floor and in turn the water above. Submarine earthquakes cause tsunamis by this water displacement. Therefore, this area is prone to tsunamis. Tsunamis are a hazard for these islands because they are very close to the convergent plates, leaving little or no time for warning.	• identifies reasons for tsunamis as – convergent plates displace the sea floor, causing earthquakes **[1 mark]** – submarine earthquakes cause tsunamis **[1 mark]** • explains why tsunamis are a hazard for the Pacific islands **[1 mark]**

Q	Sample response	The response
18a)	Carbon dioxide is being emitted at a rate faster than natural systems can sequester it. The discrepancy between the emissions and sinks is increasing with time. There is a net increase in carbon dioxide in the atmosphere over time.	• explains – there is a net increase of carbon dioxide in the atmosphere over time **[1 mark]** – emissions are higher than absorption **[1 mark]**
18b)	Human activity is possibly responsible for increased CO_2 emissions due to deforestation (reduction of CO_2 sinks). This causes an increase in atmospheric carbon dioxide over time. For example, in 1930 the difference was about 4 GT/year compared to 2020, where it is about 20 GT/year. Carbon dioxide is a greenhouse gas and increasing concentrations of greenhouse gases leads to the enhanced greenhouse effect due to its ability when in the atmosphere to reflect heat from the Earth back towards the surface. The enhanced greenhouse effect in turn leads to an increase in atmospheric temperature, which is a major driver of climate.	• suggests a cause for emissions being higher than absorption **[1 mark]** • explains – that carbon dioxide is a greenhouse gas **[1 mark]** – how increasing concentrations of greenhouse gases leads to an increase in atmospheric temperature **[1 mark]** • provides reasoning using data from the graph **[1 mark]**

Q	Sample response	The response
19	High nutrient levels will increase algal growth, which results in high oxygen demand. In this case, the likely cause is fertiliser run-off from the farmer's paddock. It can be interpreted that extra nutrients were added along the waterway 30 to 60 m. The DO is stable (0–20 m), then falls (40–60 m, 2.5 ppm), then recovers (80–100 m). The pH is stable (0–20 m), then rises (40–60 m, pH 9), then recovers (80–100 m). The turbidity is stable (0–20 m), then rises (40–60 m, 2.5 NTUs), then recovers (80–100 m). At 80 to 100 m there is a recovery phase, where levels are starting to return to levels similar to 0–20 m.	• concludes the anthropogenic cause to be – nutrients added at 30 to 60 m **[1 mark]** – likely due to fertiliser run-off **[1 mark]** • provides reasoning to support the explanation using – DO data **[1 mark]** – pH data **[1 mark]** – turbidity data **[1 mark]**

Q	Sample response	The response
20a)	The stimulus shows that east coast waters, especially off Tasmania, could warm by up to 3.5 °C by 2100. This warming causes populations to shift southward to maintain their optimum environmental conditions. The southward shift in fisheries reduces the abundance of fish populations in some places and increases it in others. A reduction in abundance reduces the sustainability of the fishery.	• explains – warming of east coast waters **[1 mark]** – a resultant shift in fish range to cooler water **[1 mark]** – changes in sustainability **[1 mark]**
20b)	A mitigation strategy that could be implemented by the Australian government would be policies that reduce carbon dioxide emissions.	• identifies a mitigation strategy **[1 mark]**
20c)	A mitigation strategy that could be implemented by local fisheries would be to reduce catch and/or effort in areas where population numbers have decreased.	• identifies a mitigation strategy **[1 mark]**

Paper 2: Short response

Q	Sample response	The response:
1a)	The maximum sustainable yield is 1200 tonnes.	• determines the maximum sustainable yield **[1 mark]**
1b)	The trend line will trend downwards, i.e. reduced biomass. If the catch does not reduce to be commensurate with the MSY, the fishery will be over-harvested.	• predicts – that the trendline will move downward **[1 mark]** – if the catch is not reduced, the fishery will be over-harvested **[1 mark]**

Q	Sample response	The response:
2a)	Many smaller continents, like in Map B, tend to have higher volcanic activity because there is more rifting and sea floor spreading. This higher volcanic activity increases the amount of atmospheric CO_2, leading to a warmer 'greenhouse' climate. Map B would therefore have a warmer climate in contrast to Map A. The warmer climate leads to higher sea levels due to thermal expansion and melting ice caps. Map B would also have higher sea levels. Higher elevations and greater distance to the oceans in continental interiors leads to cooler and drier conditions in supercontinent configurations. Map A would have a cooler climate than Map B.	• identifies – a piece of evidence of the climatic difference **[1 mark]** – a second piece of evidence of the climatic difference **[1 mark]** – a third piece of evidence of the climatic difference **[1 mark]**
2b)	The climate of Antarctica in Map B would be much warmer than Map C, because the Antarctic Circumpolar Current 'thermally isolates' Antarctica by preventing warm currents from reaching the Antarctic continent.	• identifies the temperature of Antarctica in Map B would be warmer than Map C **[1 mark]** • explains the Antarctic Circumpolar Current prevents warm currents from reaching the continent **[1 mark]**

Q	Sample response	The response:
3a)	In the biosphere, bushfires can remove or severely reduce the vegetation cover in a forest, thereby increasing erosion. The fire can also alter the structural characteristics of the soil layer, i.e. addition of ash particles. As a result of these changes, the burned area can no longer absorb as much rainfall as it could before.	• identifies – how bushfires alter forest biosphere **[1 mark]** – how bushfires alter forest soil layer **[1 mark]**
3b)	The bushfire is likely to have occurred between December 2020 and early March 2021. This is because rainfall prior to that period appears to have been absorbed (very little run-off), while rainfall after that period triggered a large amount of run-off.	• identifies – when fire occurred **[1 mark]** – pre-fire reasoning for identified time **[1 mark]** – post-fire reasoning for identified time **[1 mark]**
3c)	The alteration of vegetation by the fire increased run-off as a proportion of precipitation, therefore the run-off coefficient would increase immediately after the fire. Run off was approximately 40 m^3/s on 1 May 21 following two moderately high rain events. As the vegetation recovers, the run-off coefficient would gradually return to its pre-fire value. This would be reflected in lower run-off volumes for rain events in late 2021.	• infers that the run-off coefficient – increased immediately after the fire **[1 mark]** – decreases with time after the fire **[1 mark]** • justifies – the large volume of run-off in rain events to support an increased run-off coefficient **[1 mark]** – a lower volume of run-off in rain events in September and October 2021 to support a decreasing run-off coefficient **[1 mark]**

Q	Sample response	The response:
4a)	Land surface.	• identifies an earth system component represented in GCMs **[1 mark]**
4b)	Between 1991 and 1992, the observed SOI is negative (-5 to -13). This means that there would have been weaker trade winds due to a weaker than normal air pressure gradient across the Pacific. Warm ocean water would shift to central Pacific.	• identifies a El Nino event **[1 mark]** • explains – weaker trade winds **[1 mark]** – smaller/weaker air pressure gradient **[1 mark]** – change in location of warm oceanic water pool to central Pacific **[1 mark]**
4c)	From the graph it appears that the model is mostly invalid as it does not predict the full amplitude of actual observations very well and shows mismatches in the periodicity.	• concludes the model does not predict/capture a strong El Nino or La Nina event **[1 mark]** • justifies the conclusion with reference to – the amplitude of the model does **not** compare well with the observations **[1 mark]** – the periodicity of the model does **not** compare well with the observations **[1 mark]**
4d)	Taking into account more frequent flooding from extreme La Niña events and more frequent and extreme droughts and fire due to more frequent and extreme El Niña. Governments may need to take these factors into account when addressing infrastructure design. These events could mean governments need to also prepare flood, drought and fire relief packages and preparedness to support the community during such events.	• explains – a way governments can use the prediction **[1 mark]** – a second way governments can use the prediction **[1 mark]**

Q	Sample response	The response:
5a)	Ice cores are taken from ice sheets or glaciers, which form from the incremental build-up of snow. There is a relationship between depth and time. The deeper the core the older the source snow or ice. Small bubbles of air are trapped in ice sheets. The content of these bubbles can be extracted from an ice core and analysed to determine the atmospheric composition (including carbon dioxide) at the time of entrapment. Temperature can be inferred by measuring the ratio of water molecules containing heavy isotopes (deuterium or oxygen^{18}) to light isotopes. This is because water containing lighter isotopes is more likely to be vaporised. The warmer the air temperature is, the greater proportion of water with heavy isotopes that is present.	• explains – material is added to an ice sheet/glacier chronologically **[1 mark]** – the relationship between depth and time **[1 mark]** – data from ice cores relating to gas **[1 mark]** – data from ice cores not relating to gas **[1 mark]**
5b)	One limitation is that ice cores only record local conditions, so it is difficult to know about tropical areas. A second limitation is that ice cores only represent data for conditions during snowfall. If there is no snow during a time, no record will be left in the ice.	• explains – a limitation of using ice core analysis **[1 mark]** – a second limitation of using ice core analysis **[1 mark]**

Paper 2: Extended response — Question 6

Q	Sample response	The response:
6a)	The most suitable coordinates for a coal mine are W1. Coal has a comparatively low density to the surrounding rock. Borehole B has a low-density region at a depth of 116 to 139 metres, indicating coal is present. The deposit is horizontal as seen by the consistent low-density region in Sites W1, X1 and Y1. The most appropriate method of resource extraction is room and pillar. This is because the coal deposit is at a depth that is inappropriate to open cut mine. As the coal is horizontally deposited, extracting with room and pillar allows easy removal of the resource compared to stoping.	**For the mine location:** • determines the mine location as W1, X1 or Y1 **[1 mark]** • justifies the choice of mine site based on – one justification relating to borehole data **[1 mark]** – second justification **[1 mark]** – third justification **[1 mark]** • identifies an extraction method **[1 mark]** • justifies the extraction method **[1 mark]**
6b)	The activities of the mine including extraction of the resource and transport can cause an atmospheric impact e.g. air pollution in the form of dust and emissions. Mining activity can cause dust pollution for the native ecosystem and residents in the nearby town (atmosphere). Due to the proximity to the river, water pollution could occur (hydrosphere). Extraction, storage of resource and transport could cause soil pollution and degradation (geosphere). Mining activities along with the pollutions mentioned above can impact the distribution and abundance of organisms in the local ecosystem (biosphere). Environmental monitoring strategies include atmospheric monitoring e.g. regular air quality monitoring for dust and pollutants such as carbon monoxide/nitrous oxide/sulphur dioxide should be conducted, monitoring of the hydrosphere e.g. water quality monitoring for pH and turbidity, and monitoring of the geosphere e.g. soil quality monitoring for pH and compaction. It	**For the environmental impacts:** • describes an environmental impact on the – hydrosphere **[1 mark]** – geosphere **[1 mark]** – biosphere **[1 mark]** – atmosphere **[1 mark]** • describes an environmental monitoring strategy related to the identified impacts on the – hydrosphere **[1 mark]** – geosphere **[1 mark]** – biosphere **[1 mark]** – atmosphere **[1 mark]**

Q	Sample response	The response:
	would also be useful to monitor the biosphere by monitoring the distribution and abundance of organisms.	