BOARD OF STUDIES
NEW SOUTH WALES

2009

HIGHER SCHOOL CERTIFICATE EXAMINATION

Earth and Environmental Science

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A Geological Time Scale is provided at the back of this paper
- Write your Centre Number and Student Number at the top of pages 9, 11, 15, 19 and 39

Total marks – 100

Section I Pages 2–22

75 marks

This section has two parts, Part A and Part B

Part A – 15 marks

- Attempt Questions 1–15
- Allow about 30 minutes for this part

Part B – 60 marks

- Attempt Questions 16–27
- Allow about 1 hour and 45 minutes for this part

Section II Pages 23–35

25 marks

- Attempt ONE question from Questions 28–31
- Allow about 45 minutes for this section

Section I
75 marks

Part A – 15 marks
Attempt Questions 1–15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet for Questions 1–15.

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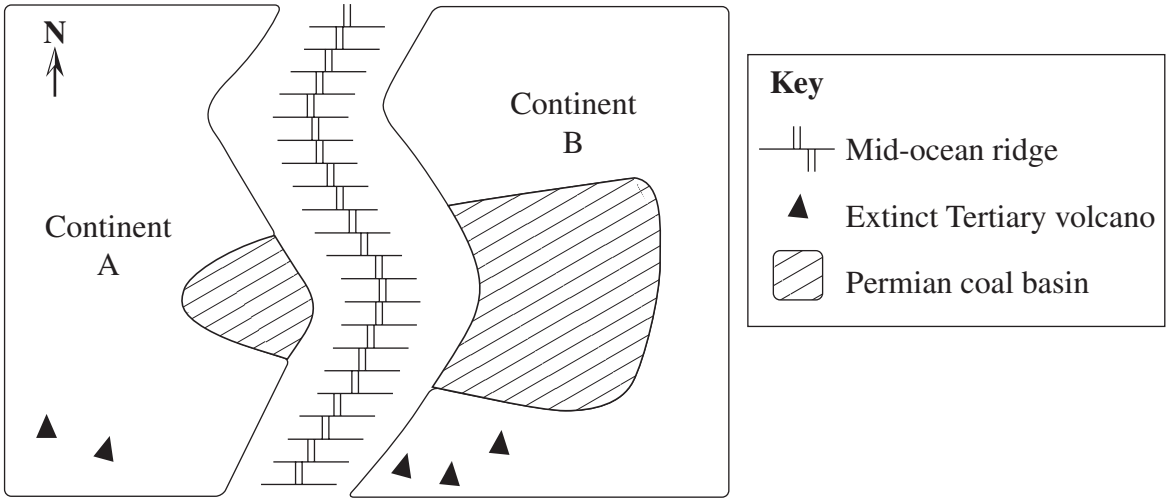
1 The diagram shows two continents with several geological features and a plate boundary.



What geological setting is shown in the diagram?

(A) Divergent boundary with Continents A and B moving apart

(B) Transform fault with Continents A and B moving closer together

(C) East-west conservative boundary with Continents A and B moving apart

(D) North-south convergent boundary with Continent A moving south and Continent B moving north

2 Which material from large explosive volcanic eruptions contributes most to a decrease in global temperatures?

(A) Carbon dioxide (CO_2)

(B) Sulfur dioxide (SO_2)

(C) Water vapour (H_2O)

(D) Radon (Rn)

3 The table summarises some features of hazards associated with volcanic activity.

Hazard	*Features*
Lahar	A fast moving mixture of hot water and volcanic debris that travels along topographic depressions.
Acid rain	Acid rain is produced by rain water falling through volcanic emissions. It can be as corrosive as battery acid.
Volcanic gases	CO_2 and SO_2 can be released into the atmosphere during an eruption or may escape continuously into the atmosphere prior to an eruption.

Which of the following is a valid inference based on the information in the table?

(A) Lahars and volcanic gases have similar features.

(B) Volcanic gases are only a risk during periods of active eruption.

(C) The majority of deaths during an eruption are caused by acid rain.

(D) Risks from lahars can be minimised if people build on topographic highs.

4 What is the plate tectonic super-cycle?

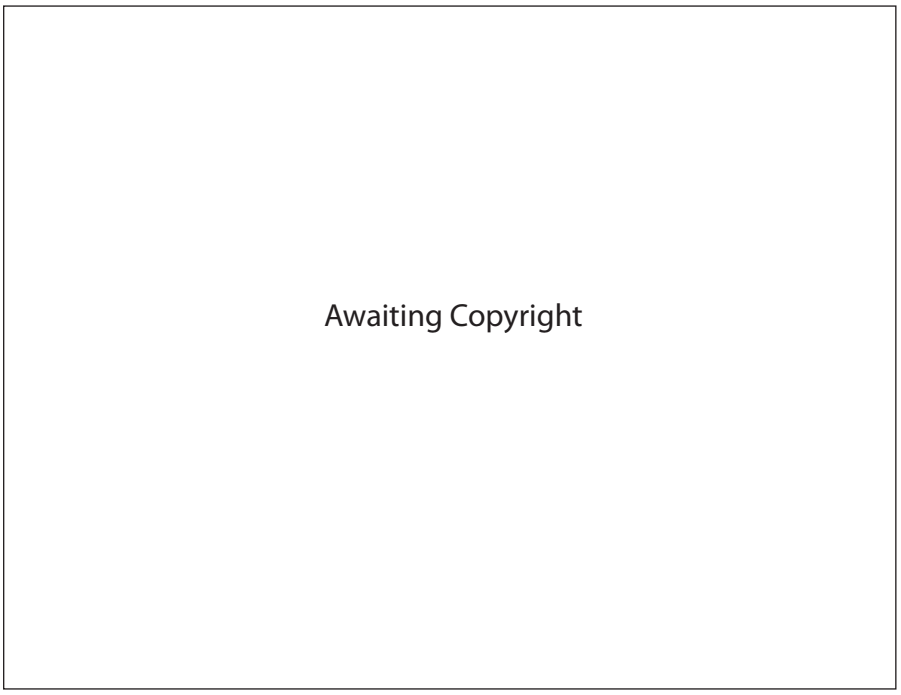
(A) The cyclic pattern in the rate of motion of two plates at divergent boundaries

(B) The regular cyclic motion of supercontinents around the equator

(C) The ongoing cycle of formation and breakup of supercontinents

(D) The recycling of lithospheric plates at convergent boundaries

5



Of the points A, B, C or D marked on the map, at which location would a deep focus earthquake be most likely to occur?

(A) A

(B) B

(C) C

(D) D

6 In the fossil record, terrestrial vertebrates first appeared in the Devonian Period.

What advantage did the terrestrial environment offer these vertebrates?

(A) Less exposure to ultraviolet radiation

(B) Greater variation in temperature

(C) Less competition for resources

(D) Greater variety of land plants

7 What is the best description of Ediacaran metazoans?

(A) Simple single-celled organisms

(B) Soft-bodied multicellular animals

(C) Animals with hardened body parts

(D) Primitive photosynthetic organisms

8 Which of the following is the likely cause of an explosive radiation of new species following a mass extinction event?

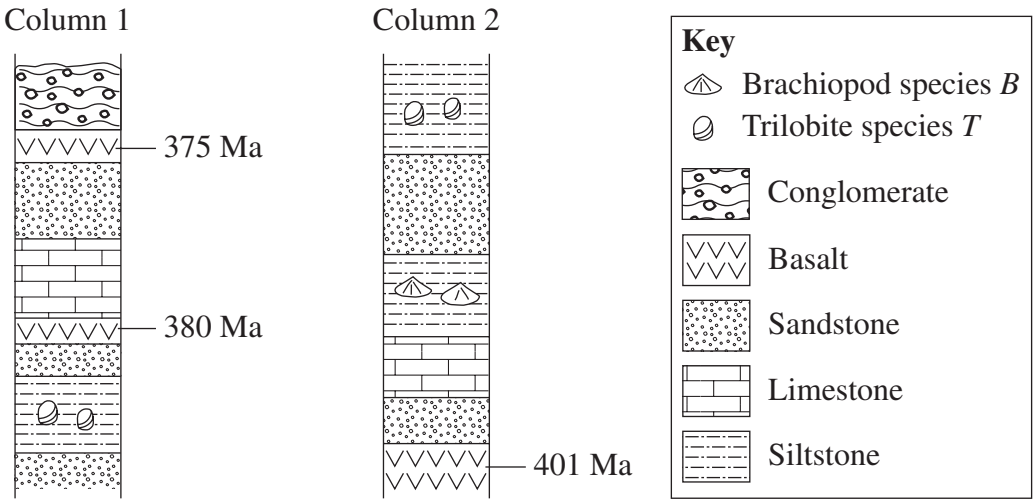
(A) Increased competition between organisms

(B) A significant environmental change

(C) Depletion of the ozone layer

(D) The mutation of DNA

9 The diagram shows two stratigraphic columns for a sedimentary basin.



What is the likely age of the Brachiopod species *B*?

(A) Between 380 Ma and 401 Ma

(B) Younger than trilobite species *T*

(C) Younger than 375 Ma

(D) Older than 401 Ma

10 How do fossils provide evidence that supports the theory of evolution by natural selection?

(A) They can be mapped to indicate the distribution of each species.

(B) They can be analysed to interpret competition between species.

(C) They can be compared to show similarities between species.

(D) They can be dated to determine an absolute age.

11 Scientists study the relationship between changes in past environments and changes in fossil life forms.

What do the results of these studies allow scientists to do better?

(A) Implement scientific procedures

(B) Predict the future life forms that will evolve

(C) Implement strategies to stop environmental change

(D) Predict the potential impact of environmental changes on modern life forms

12 To simulate the effect of chlorofluorocarbons (CFCs) on ozone in the atmosphere, quantities of ozone, oxygen and a CFC are placed in a sealed container which contains a source emitting ultraviolet radiation.

Which of the following changes are most likely to occur after one month of exposure to ultraviolet radiation?

	Ozone	*Oxygen*	*CFC*
(A)	Decrease	Increase	Decrease
(B)	Increase	Increase	Increase
(C)	Increase	Decrease	Decrease
(D)	Decrease	Decrease	Increase

13 Why are most Australian soils less fertile than those on other continents?

(A) Most Australian soils have been intensively farmed.

(B) Australia's low mountains contribute to significant rainfall.

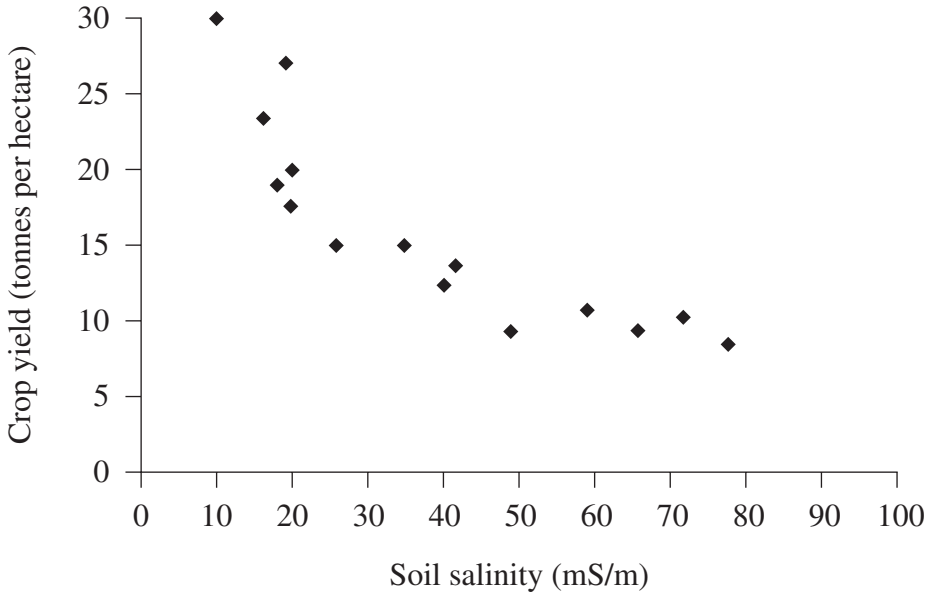
(C) Most Australian soils form by the slow weathering of lateritic rocks.

(D) Most of the Australian continent is geologically very old and tectonically stable.

14 Which of the following correctly identifies an international strategy, its purpose and its intended outcome?

	Strategy	*Purpose*	*Intended outcome*
(A)	Kyoto	To reduce greenhouse gas emissions	Reduction in UV radiation reaching Earth's surface
(B)	Montreal	To reduce greenhouse gas emissions	Reduction in global warming caused by humans
(C)	Kyoto	To reduce production of ozone depleting chemicals	Reduction in global warming caused by humans
(D)	Montreal	To reduce production of ozone depleting chemicals	Reduction in UV radiation reaching Earth's surface

15 The graph shows the relationships between crop yield and soil salinity measured on farms in an area of NSW.



What is the likely crop yield in tonnes per hectare on a farm in this area of NSW, where the soil salinity is 100 mS/m?

(A) 0

(B) 3

(C) 7

(D) 15

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Centre Number

Student Number

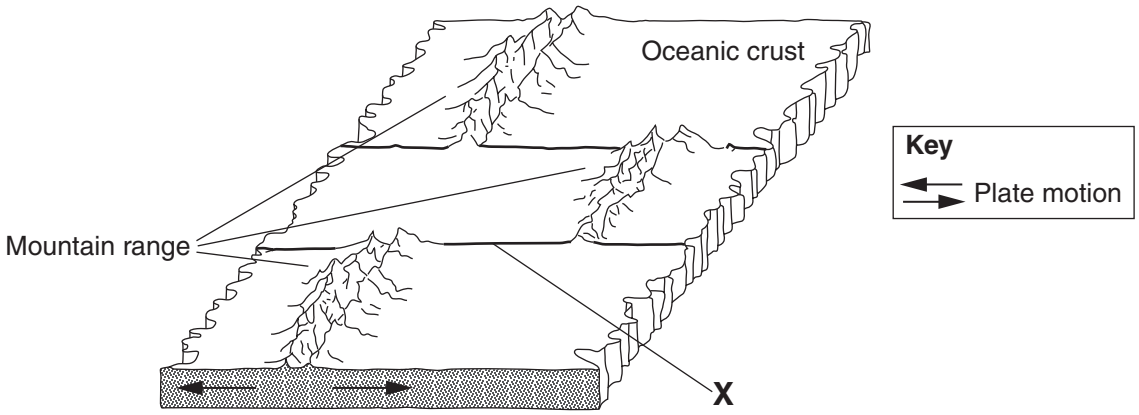
Section I (continued)

Part B – 60 marks
Attempt Questions 16–27
Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided.

Question 16 (5 marks)

The diagram shows a section of Earth's crust.



(a) Identify the structure labelled **X**. **1**

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(b) (i) The mountain range in the diagram forms at a plate boundary. **1**

Identify the type of plate boundary.

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(ii) Explain the tectonic process that leads to the formation of this type of mountain range. **3**

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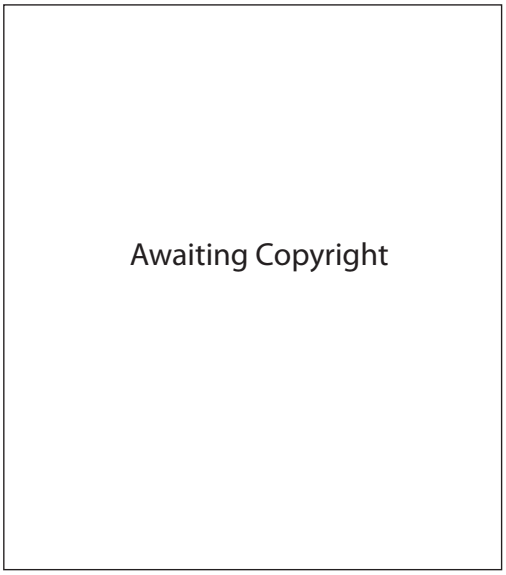
Question 17 (7 marks)

(a) The map shows the distribution of epicentres of large-magnitude earthquakes.



Why are earthquakes located in the pattern shown on the map? **1**

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(b) Identify ONE technology that can be used to predict earthquakes, and explain how it works. **3**

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(c) Explain ONE impact that earthquakes have on the built environment. **3**

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Question 18 (4 marks)

Explain the role of subduction in the growth of the Australian continent. **4**

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Please turn over

Question 19 (5 marks)

On 8 August 2008 the island arc volcano Kasatochi erupted explosively producing large amounts of sulfur dioxide (SO_2), carbon dioxide (CO_2), water vapour (H_2O) and other gases.

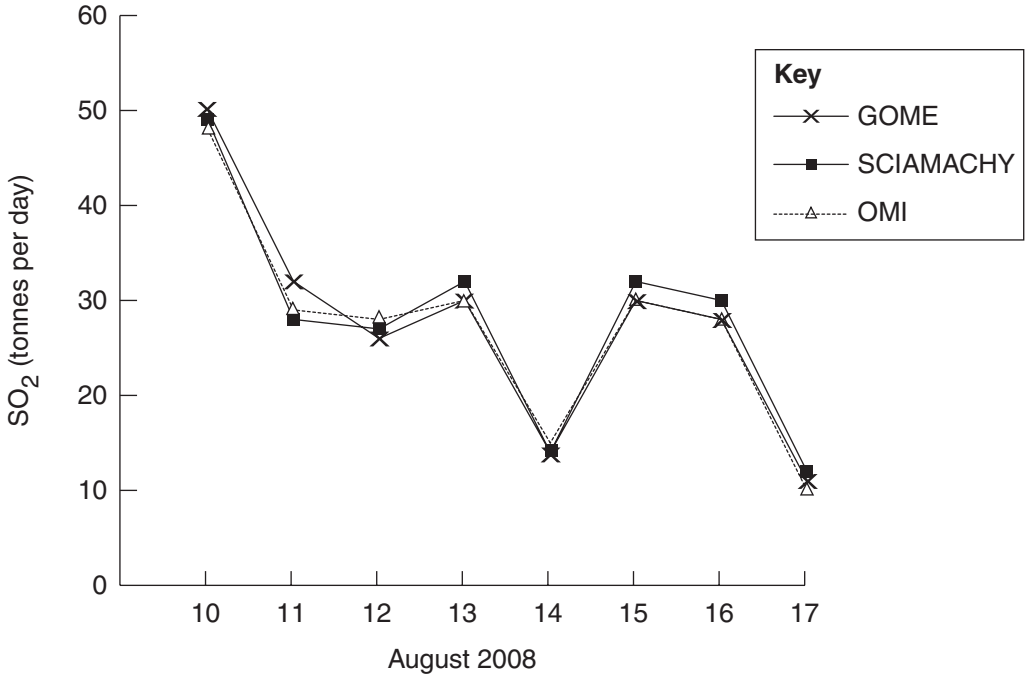
(a) Draw a labelled cross-section of the type of plate boundary that could produce a volcano such as Kasatochi. **3**

Question 19 continues on page 13

Question 19 (continued)

(b) The following graph shows the daily emissions of SO_2 directly above the Kasatochi volcano in the period 10–17 August 2008 as measured by: **2**

- GOME (Global Ozone Monitoring Experiment — on board the European Remote Sensing Satellite)
- SCIAMACHY (an imaging spectrometer operated by the European Space Agency)
- OMI (the Ozone Monitoring Instrument — jointly operated by the UK Meteorological Office and the National Centre for Environmental Prediction).



Explain why these data can be considered to be both accurate and reliable.

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End of Question 19

Question 20 (7 marks)

(a) Identify the organisms responsible for the formation of 3.4 billion-year-old stromatolites in Australia. **1**

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(b) Account for the change in both the abundance and distribution of stromatolites over time. **3**

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(c) Explain the role of photosynthetic organisms in the development of the ozone layer. **3**

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Question 21 (6 marks)

(a) Outline TWO features of land plants that have enabled them to survive in terrestrial environments. **2**

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(b) Why have reptiles been more successful than amphibians in exploiting terrestrial environments? **4**

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Question 22 (3 marks)

(a) Identify ONE feature of Early Phanerozoic organisms that Late Proterozoic organisms did not have. **1**

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(b) Describe an advantage the feature gave to the Early Phanerozoic organisms. **2**

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Question 23 (4 marks)

Assess a practice for managing agricultural pests that is an alternative to the use of pesticides. **4**

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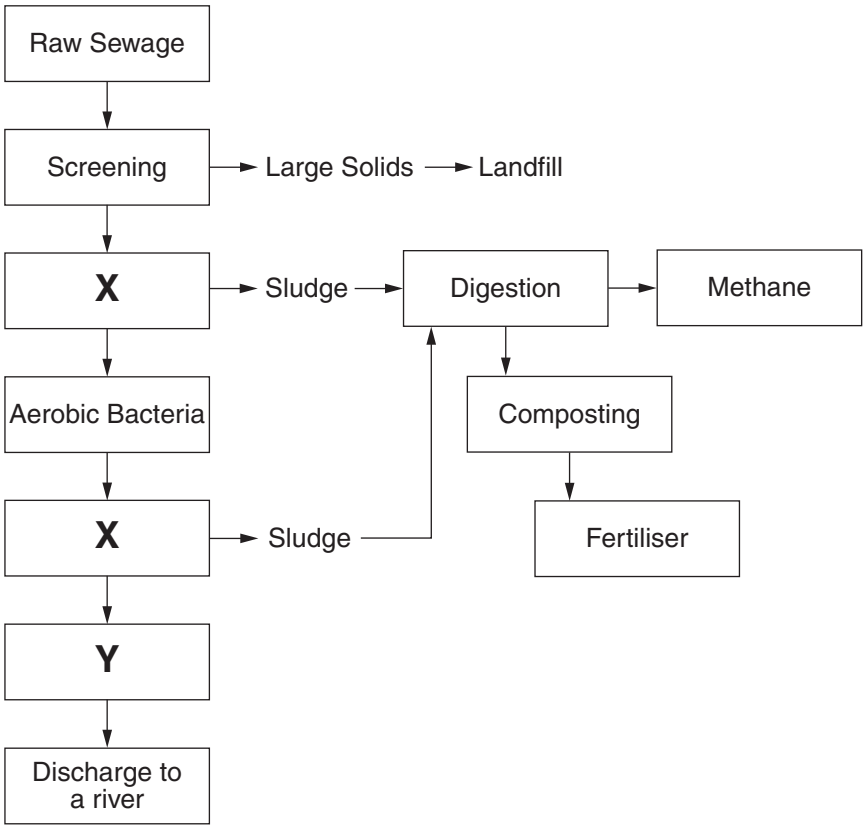
Question 24 (4 marks)

The diagram shows a flowchart for the treatment of sewage.



(a) Process **X** appears twice in this flowchart. What is process **X**? **1**

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(b) (i) Identify a process that could be used at **Y**. **1**

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(ii) Justify the use of the process you identified in part (b) (i). **2**

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Question 25 (4 marks)

Name TWO methods that could be used to rehabilitate a contaminated mine site. Justify your choice of these methods. **4**

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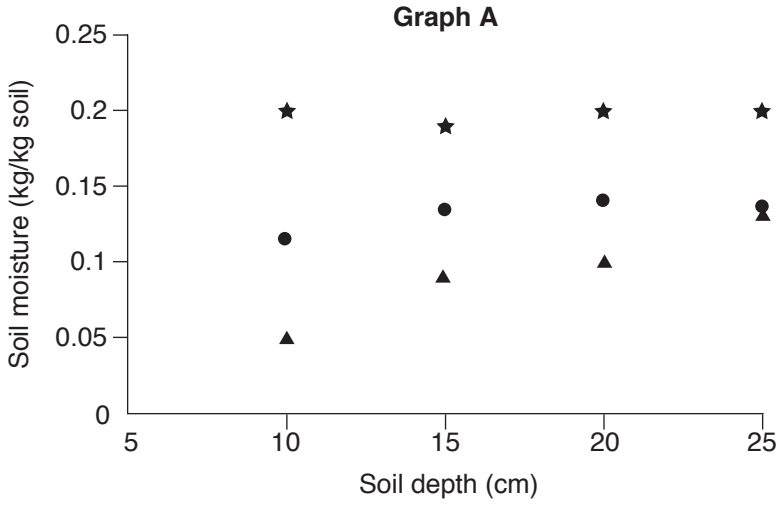
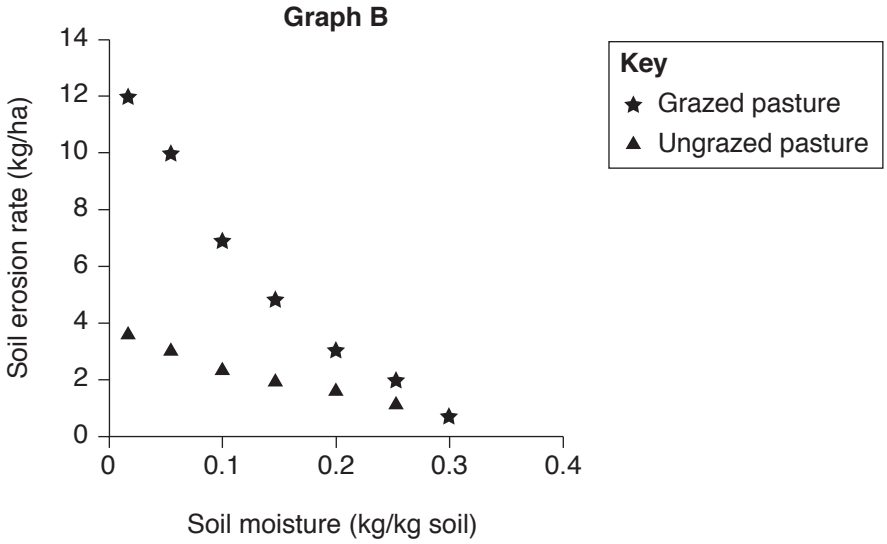
Question 26 (4 marks)

The data in Graphs A and B were obtained from the same pasture land in NSW. Graph A shows soil depth, soil moisture and number of sheep per hectare (ha).



Stocking rates & soil moisture content of pasture land, New South Wales State of Environment, 1997. Reproduced with permission by the NSW Environmental Protection Authority.

Graph B shows soil moisture and erosion rates for two paddocks, one which had been grazed by sheep and a second left ungrazed.



Question 26 continues on page 21

Question 26 (continued)

(a) Using information in Graph A, identify the relationship between soil moisture and the number of sheep per hectare. **1**

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(b) Using information from both graphs, justify a strategy to reduce the rate of soil erosion on a sheep farm. **3**

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End of Question 26

Question 27 (7 marks)

Analyse how features of the Australian environment and the unsustainable use of resources have contributed to the extinction of organisms since the arrival of humans in Australia. **7**

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Earth and Environmental Science

Section II

25 marks
Attempt ONE question from Questions 28–31
Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.

Question 28 — Introduced Species and the Australian Environment (25 marks)

(a) (i) Name an introduced plant that has become a pest in Australia. **1**

For the plant named in part (a) (i):

(ii) Identify ONE reason why it was introduced into Australia. **1**

(iii) Outline how it was able to disperse within the Australian environment. **1**

(iv) Identify ONE strategy that can be used to control it. **1**

(b) One control program for pests such as the European Red Fox is to use poison baits. This method involves attracting the pest with fresh feeds (for example pieces of meat) followed by the poison baits (for example pieces of meat with poison) several days later.

(i) Identify a potential risk of the use of this control program. **1**

The table gives data for one control program in a bushland reserve in a Sydney suburb.

Date	*Fresh feeds laid*	*Fresh feeds taken*	*Poison baits laid*	*Poison baits taken*
April 2005	31	20	0	–
September 2005	55	50	24	21
April 2006	22	1	20	0
September 2006	12	7	24	10
September 2007	0	–	20	3
September 2008	0	–	13	1

(ii) Using the data in the table, evaluate the effectiveness of the control program. **3**

Question 28 continues on page 25

(c) (i) Outline TWO criteria used to determine the conditions under which an organism can be used for biological control. **2**

(ii) Compare the use of bacterial/viral parasites with the release of sterilised males as biological controls. **2**

(d) The table gives information for an introduced plant species.

Average soil phosphorus level (ppm)	*Numbers of an introduced plant species per 100 m^2*
15	5
20	7
25	21
30	32
35	40
40	56
45	59

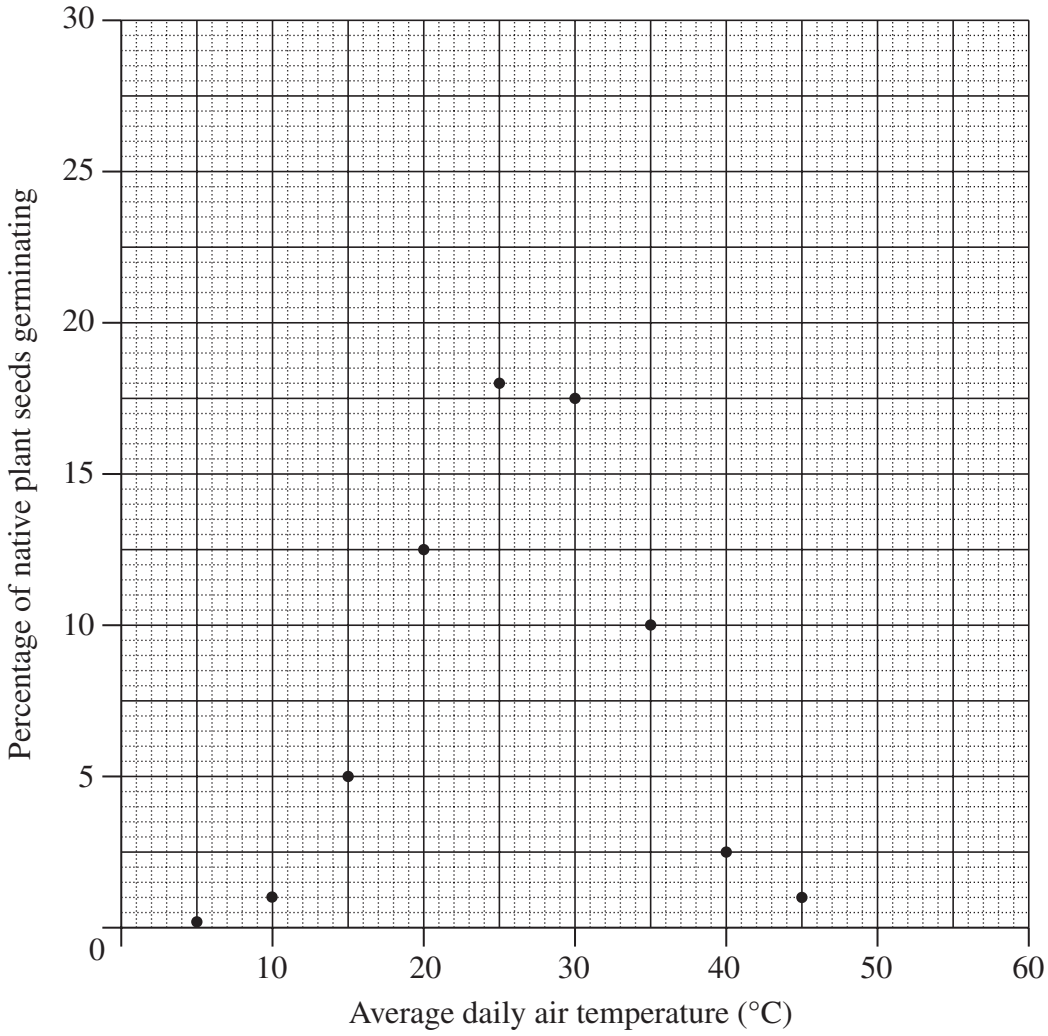
(i) Identify the independent variable in the table. **1**

(ii) Detach the graph paper on page 39. Plot the information given in the table onto the graph paper. **3**

Question 28 continues on page 26

Question 28 (continued)

(e) The graph shows the relationship between average daily temperature and the percentage of seeds germinating.



Analyse the trend in the graph. **3**

(f) Analyse the impact that species introduced into Australia, apart from humans, have had on the biotic and abiotic components of the Australian environment. Use examples in your answer. **6**

End of Question 28

Question 29 — Organic Geology – a Non-renewable Resource (25 marks)

(a) (i) Name ONE coal-producing locality. **1**

(ii) What is the element that is the most abundant by mass in fossil fuels? **1**

(iii) What property of crude oil allows it to be separated into its various fractions during distillation? **1**

(iv) Identify ONE product of burning fossil fuels that is not a gas. **1**

(b) The table shows world energy usage in terawatts (TW=10^{12} watts) from 1965 to 2005, and gives projected world energy usage for 2025 and 2055.

Year	*Oil (TW)*	*Coal (TW)*	*Gas (TW)*	*Other Energy Sources (TW)*
1965	2.0	2.0	0.8	0.1
1975	3.5	2.2	1.5	0.2
1985	3.7	2.7	2.0	0.4
1995	4.3	3.0	2.5	0.6
2005	5.0	3.8	3.3	0.9
2025	4.0	3.8	3.8	2.1
2055	1.5	3.9	4.3	4.4

(i) Using information in the table, predict ONE economic effect of projected world energy usage. **1**

(ii) Justify the use of ONE other energy source in meeting future world energy demand. **3**

Question 29 continues on page 28

Question 29 (continued)

(c) (i) What is catalytic cracking in petroleum refining? **1**

(ii) Outline the maturation of petroleum including diagenesis, catagenesis and metagenesis. **3**

(d) The table shows the percentage of carbon in some fossil fuels and the amount of carbon dioxide produced during combustion.

Carbon in fuel (%)	*Carbon dioxide production during combustion (g CO_2/100 g fuel)*
10	5
25	15
35	17
50	24
70	30
85	43
95	50

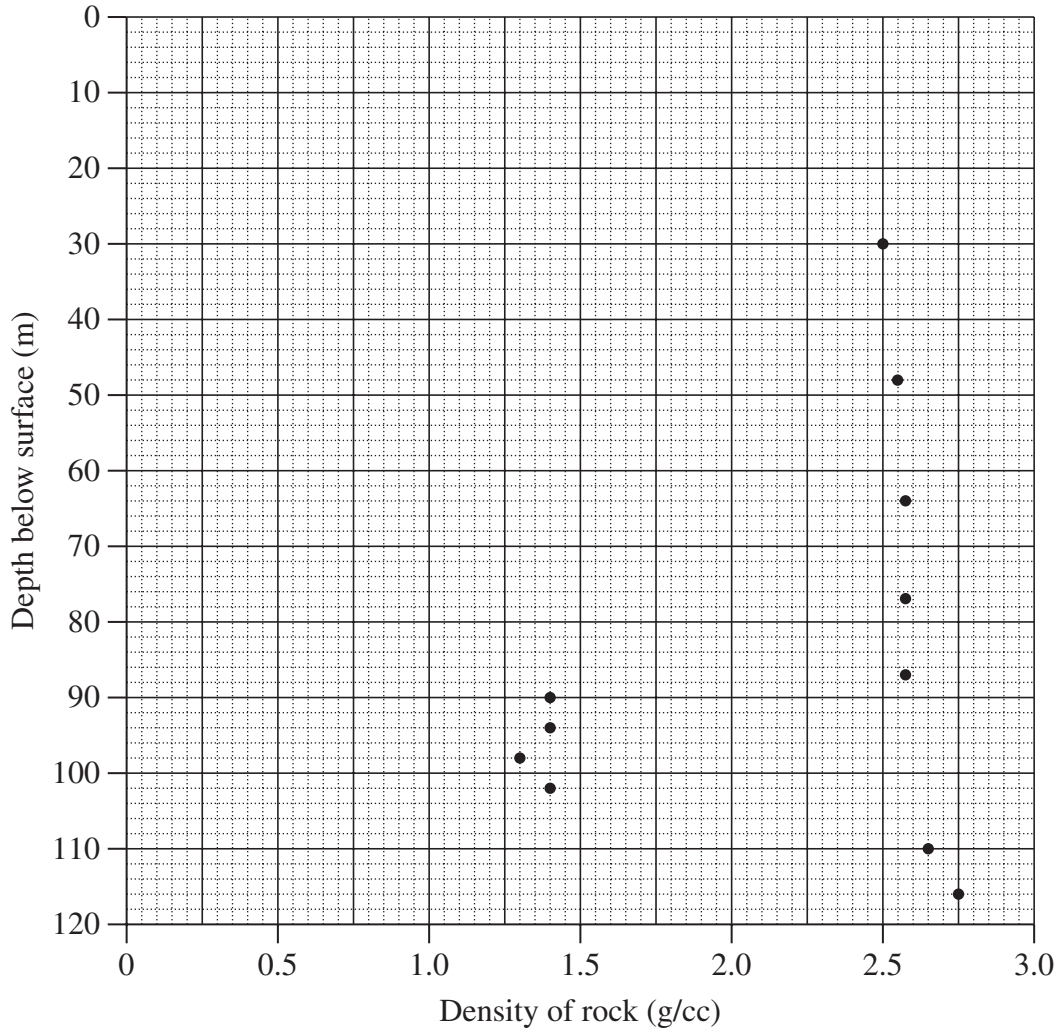
(i) Identify the independent variable in the table. **1**

(ii) Detach the graph paper on page 39. Plot the information given in the table onto the graph paper. **3**

Question 29 continues on page 29

Question 29 (continued)

(e) The graph shows the relationship between depth and rock density in a coal basin.



Analyse the trend in the graph. **3**

(f) Analyse how the geology of both coal deposits and petroleum accumulations influences exploration techniques for these resources. **6**

End of Question 29

Question 30 — Mining and the Australian Environment (25 marks)

(a) (i) Identify ONE 'landmark decision' of the High Court of Australia which has had an impact on mining operations in Australia. **1**

(ii) Identify ONE effect of the decision identified in part (a) (i) on the exploitation of a mineral deposit. **1**

(iii) Give an example of a base metal. **1**

(iv) What is ONE renewable resource? **1**

(b) The table gives details of some major mineral provinces in Australia.

Resource in the Province	*Current reserves (Mt)*	*Current ore production (Mt per year)*
Iron	1400	100
Nickel	600	30
Silver, lead, zinc	15	2
Copper, gold	480	30
Titanium	400	4

(i) Using information in the table, predict which resource will last the longest. **1**

(ii) For ONE mineral province in Australia, describe ONE model of mineral genesis responsible for mineralisation that is found there. **3**

(c) (i) Outline ONE exploration method that was significant in the discovery of a named ore deposit. **1**

(ii) Assess the extent to which the provision of infrastructure has had an impact on the feasibility of mining the ore deposit in part (c) (i). **3**

Question 30 continues on page 31

Question 30 (continued)

(d) The table gives information for ore grade and magnetic intensity of the ore.

Grade of ore (% copper)	*Magnetic intensity of the ore (gamma)*
0	60
5	72
10	76
15	90
20	100
25	106
30	118

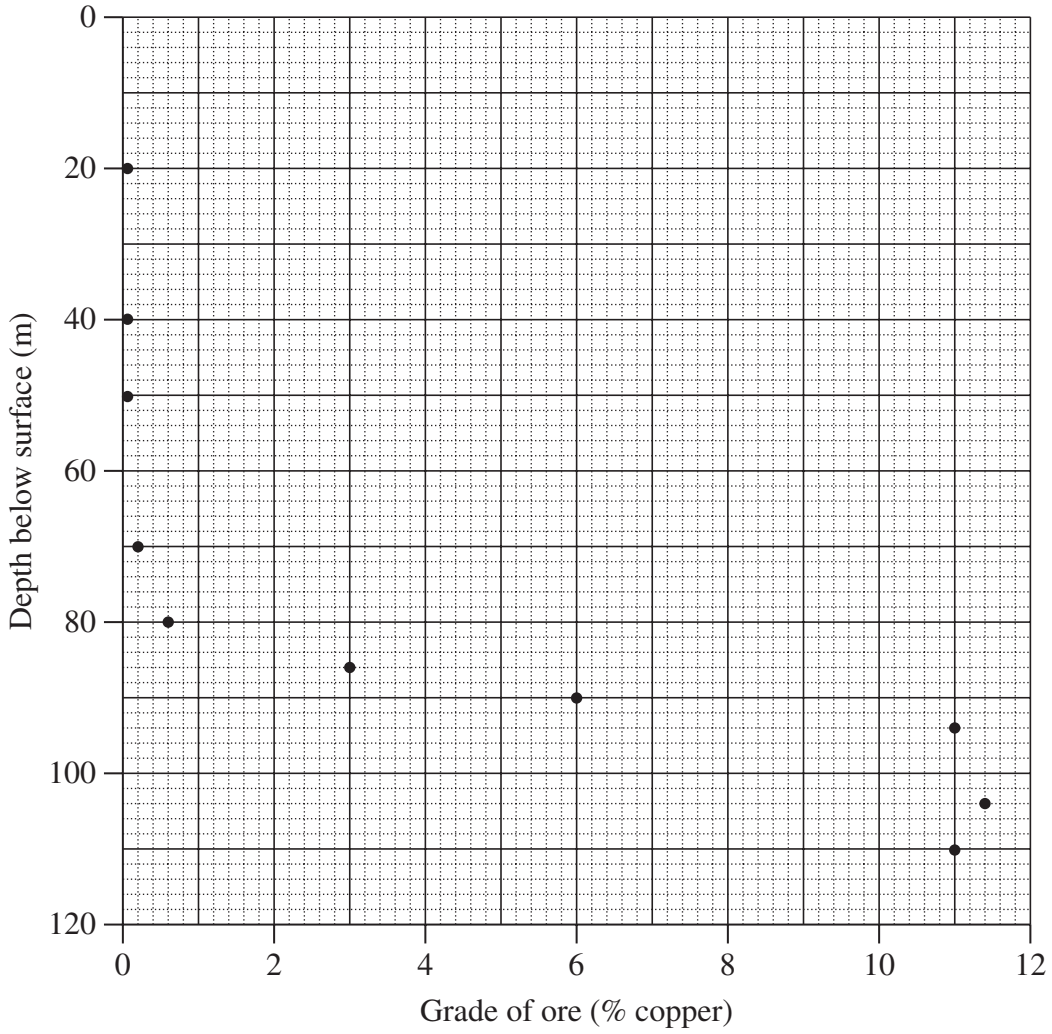
(i) Identify the independent variable in the table. **1**

(ii) Detach the graph paper on page 39. Plot the information given in the table onto the graph paper. **3**

Question 30 continues on page 32

Question 30 (continued)

(e) The graph shows the relationship between ore grade and depth below the surface.



Account for the trend in the graph. **3**

(f) Evaluate the sustainability of mining in Australia in terms of environmental impact and resource limitations. **6**

End of Question 30

Question 31 — Oceanography (25 marks)

(a) (i) What is the average value of the salinity of modern oceans? **1**

(ii) Outline ONE process that contributes to the salinity of oceans. **1**

(iii) Identify ONE possible origin of Earth's oceanic water. **1**

(iv) Identify ONE region of the crust where new ocean basins are forming. **1**

(b) The map shows mass water movement in the Pacific Ocean, Indian Ocean and Atlantic Ocean.

What is ONE consequence of using ocean sewage outlets in northern Australia? **2**

(c) How has an increased understanding of oceans changed society's use of ONE ocean resource? **2**

Question 31 continues on page 34

Question 31 (continued)

(d) (i) Describe how ONE of the following technologies provides information about the oceans: **2**

- Echo sounder
- Core sampler
- Bathythermograph
- Magnetometer

(ii) Why should we develop new technologies to study the oceans? **2**

(e) The table gives information for water temperature and the mass of sodium chloride dissolved in water.

Water temperature (°C)	*Mass of sodium chloride dissolved in water (g)*
5	2
10	3
15	8
20	13
25	14
30	17

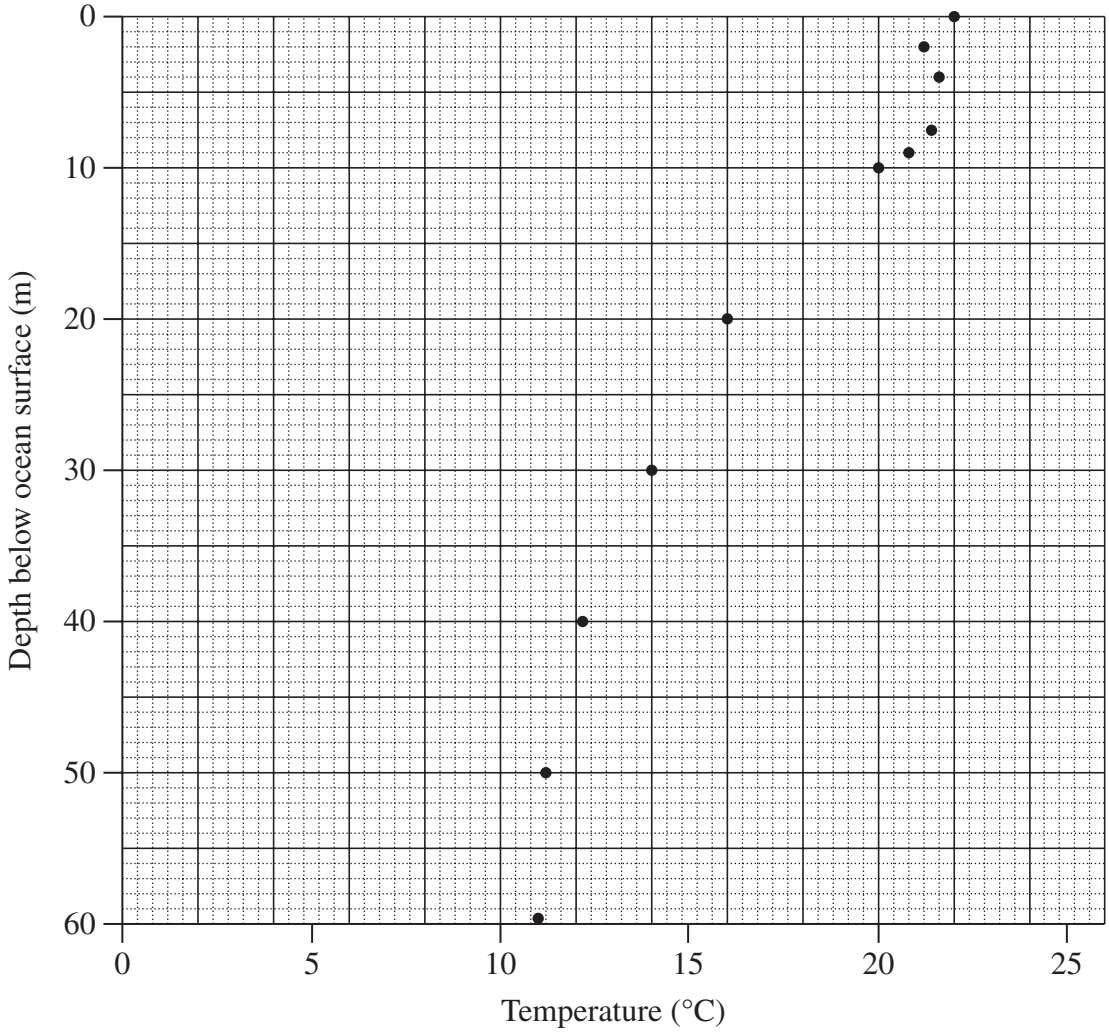
(i) Identify the independent variable in the table. **1**

(ii) Detach the graph paper on page 39. Plot the information given in the table onto the graph paper. **3**

Question 31 continues on page 35

Question 31 (continued)

(f) The graph shows the relationship between temperature and depth below the ocean surface.



Analyse the trend in the graph. **3**

(g) Analyse the role of physical conditions, including availability of light at different depths in the oceans, in determining the distribution of marine communities and the types of sediments found on the ocean floor. **6**

End of Paper

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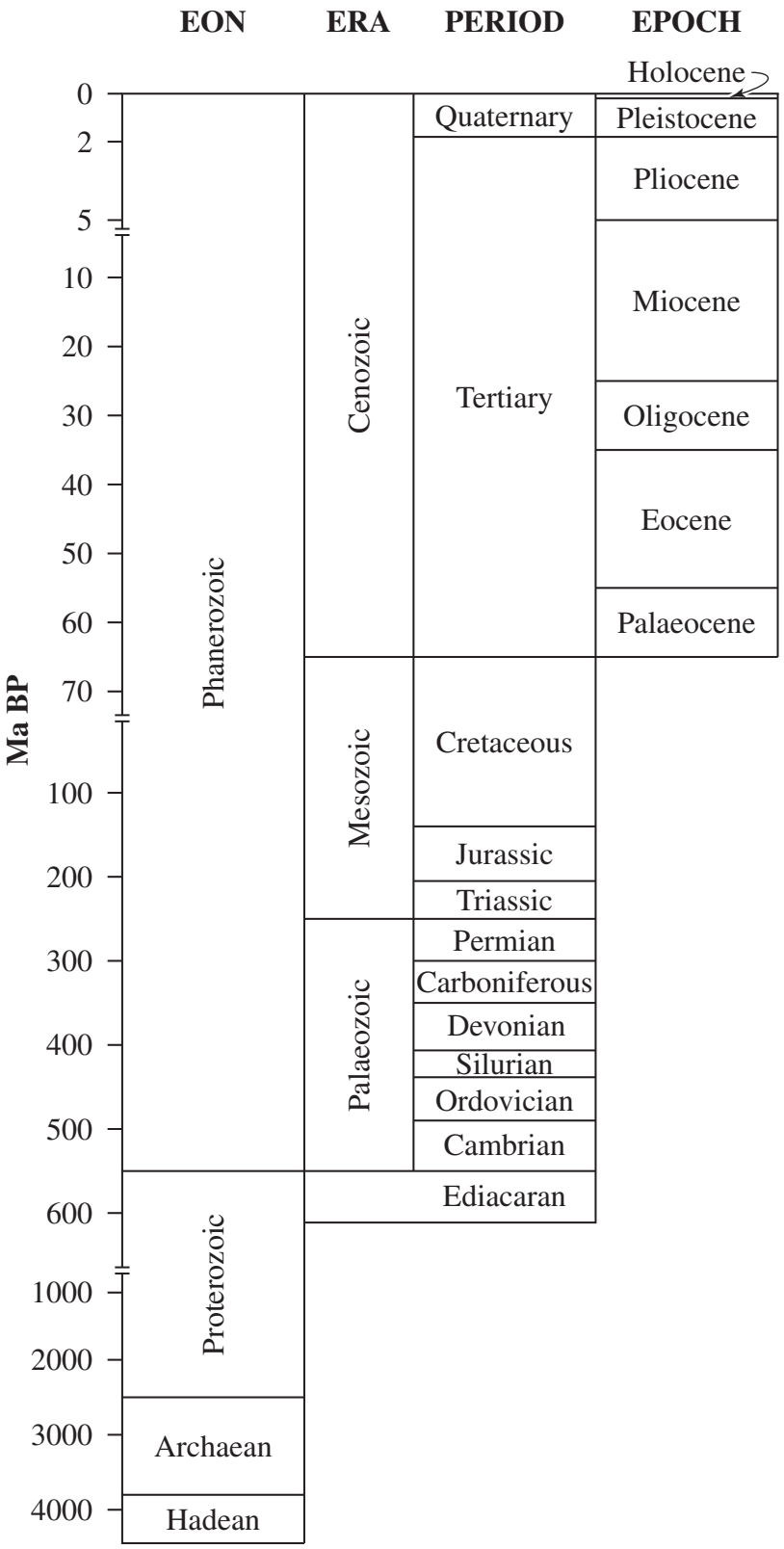
Geological Time Scale



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2009 HIGHER SCHOOL CERTIFICATE EXAMINATION

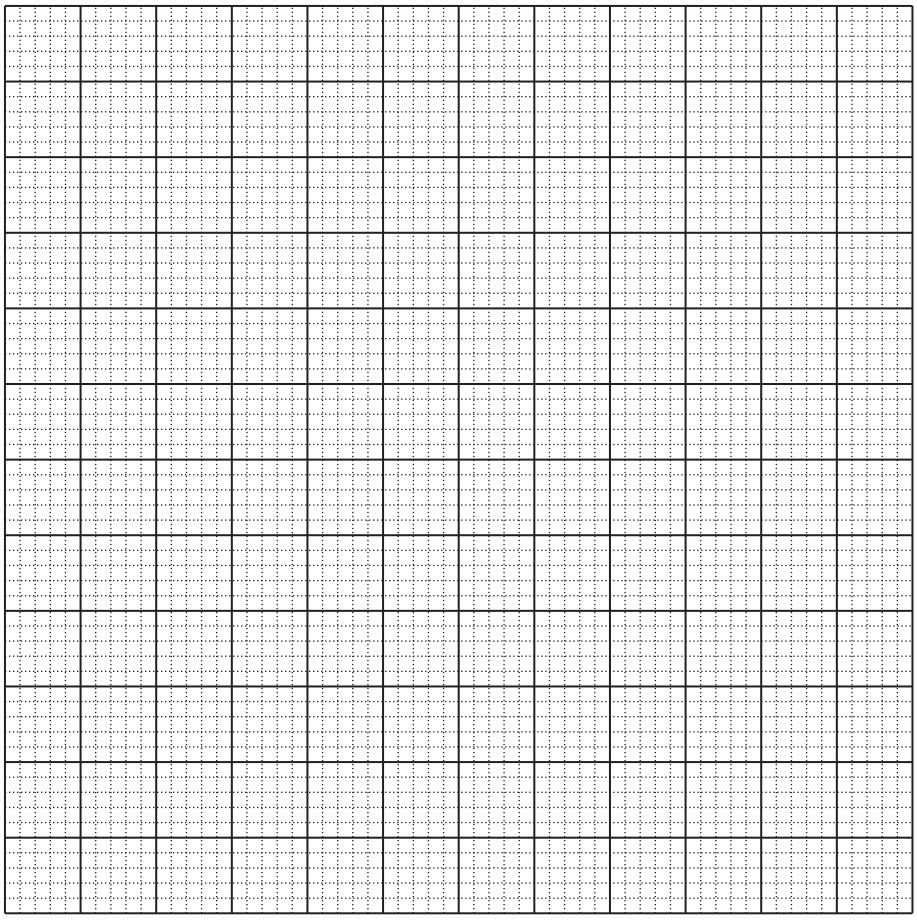
Earth and Environmental Science

Centre Number

Student Number

This page is to be detached, completed and attached to the inside front cover of your writing booklet for the option question you have completed.

Question attempted



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