



## ATAR course examination, 2019

### Question/Answer booklet

# EARTH AND ENVIRONMENTAL SCIENCE

Please place your student identification label in this box

WA student number: In figures

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In words

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### Time allowed for this paper

Reading time before commencing work: ten minutes

Working time: three hours

### Materials required/recommended for this paper

#### *To be provided by the supervisor*

This Question/Answer booklet

Multiple-choice answer sheet

Number of additional  
answer booklets used  
(if applicable):

#### *To be provided by the candidate*

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: protractor, drawing compass, mathomat, non-programmable calculators approved for use in this examination

### Important note to candidates

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

**Structure of this paper**

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of examination
Section One Multiple-choice	15	15	20	15	15
Section Two Short answer	9	9	100	110	55
Section Three Extended answer	3	2	60	30	30
<b>Total</b>					100

**Instructions to candidates**

1. The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2019*. Sitting this examination implies that you agree to abide by these rules.
2. Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Sections Two and Three: Write your answers in this Question/Answer booklet.

3. You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.
4. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.
5. The tear-out page is not to be handed in with your Question/Answer booklet.

## Section One: Multiple-choice

15% (15 Marks)

This section has **15** questions. Answer **all** questions on the separate Multiple-choice answer sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 20 minutes.

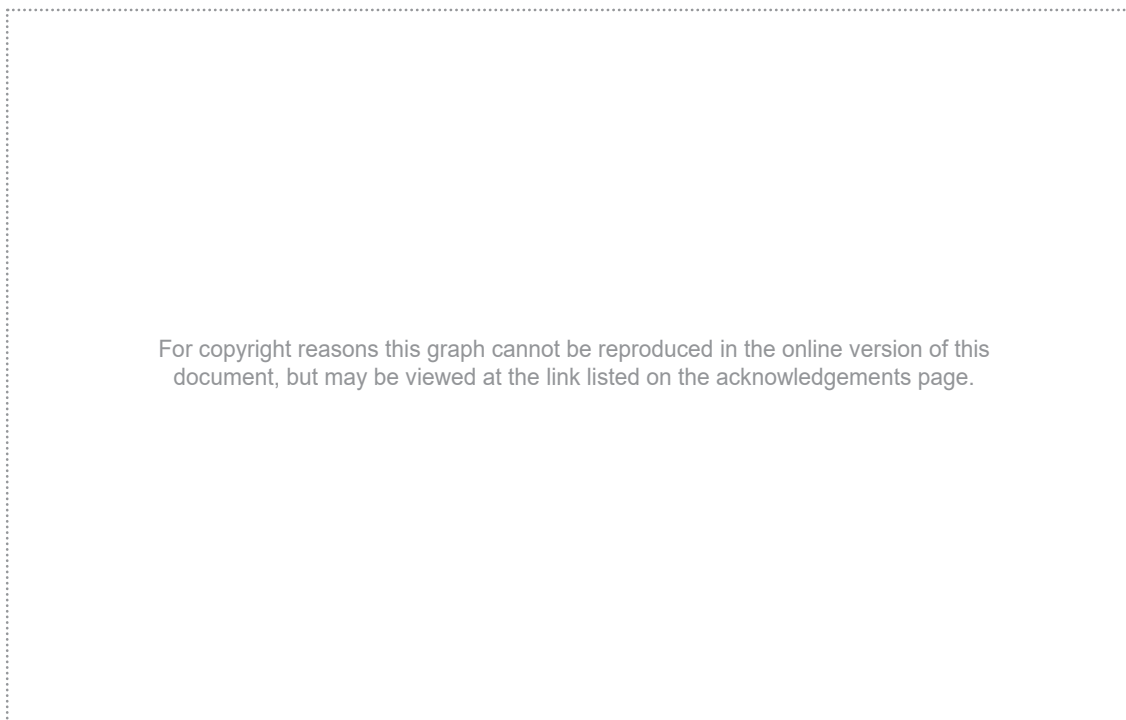
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1. Some 125 000 years ago, global sea levels were 5 m higher than today. They decreased slowly from this high point, falling as far as 120 m below current levels 20 000 years ago. The **most** likely explanation for this long-term fall in sea level is
  - (a) an increase in sea ice, resulting from decreased global volcanism.
  - (b) an increase in glaciers and ice sheets as Earth progressed through an ice age.
  - (c) a gradual change in the frequency of sunspot activity.
  - (d) the rapid increase in the Earth's human population during this period.
  
2. In 2012, almost 13 000 fish were found dead in the Swan River. Eutrophication was found to be the most likely cause. Which of the following **best** describes the process of eutrophication?
  - (a) increased nutrients in the water, leading to increased aquatic plant growth and decreased oxygen levels
  - (b) poisoning of a fish population by the release of toxic chemicals into the waterway
  - (c) death of younger fish due to extreme water temperatures produced by a period of consistently high summer temperatures
  - (d) increase in carbon dioxide levels in the water due to low rain levels and decreased tidal flow
  
3. One way to predict the effect of a human population on the environment is to determine its ecological footprint. Which of the following is the **best** measure of a population's ecological footprint?
  - (a) the total amount of greenhouse gases the population releases into the atmosphere
  - (b) the area of land covered by the population's urban structures, such as cities and towns
  - (c) the amount of agricultural land required to produce food for the population
  - (d) the amount of land required to sustain the population's use of natural resources
  
4. Remote sensing technologies are used extensively in the exploration for mineral deposits such as iron, nickel and gold. Which of the following is **not** an example of remote sensing?
  - (a) aerial photography
  - (b) satellite-based infrared spectroscopy
  - (c) geochemical sampling
  - (d) sonar systems on ships

See next page

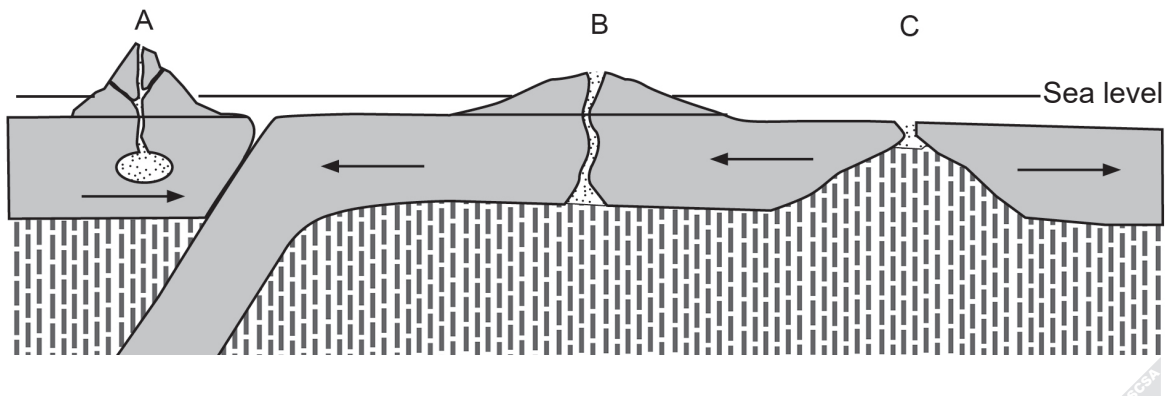
5. Which of the following would have the largest effect on the exchange of water within Earth's hydrological systems?
- (a) changing to aerosols that are free of hydrofluorocarbons
  - (b) removal of trees and vegetation
  - (c) reduction in the use of potassium-rich fertilisers
  - (d) implementation of carbon sequestration
6. The Gnamagara aquifer is a major source of fresh water for Perth. The average level of groundwater in this aquifer from 1997 to 2016 is shown in the graph below.

**Average level of groundwater, Gnamagara aquifer, 1997–2016**



- Which of the following is **unlikely** to have been a significant cause of this trend?
- (a) the introduction of managed aquifer recharge in Western Australia
  - (b) the declining rainfall affecting southern Western Australia
  - (c) an increase in the population of Perth
  - (d) an increase in the number of buildings and roads on the aquifer's catchment
7. Fire is a destructive but essential component of many Australian ecosystems. Which of the following is a long-term negative impact of fire events?
- (a) increased soil erosion
  - (b) reshooting of endemic tree species
  - (c) release of nutrients from the biomass
  - (d) removal of plant undergrowth

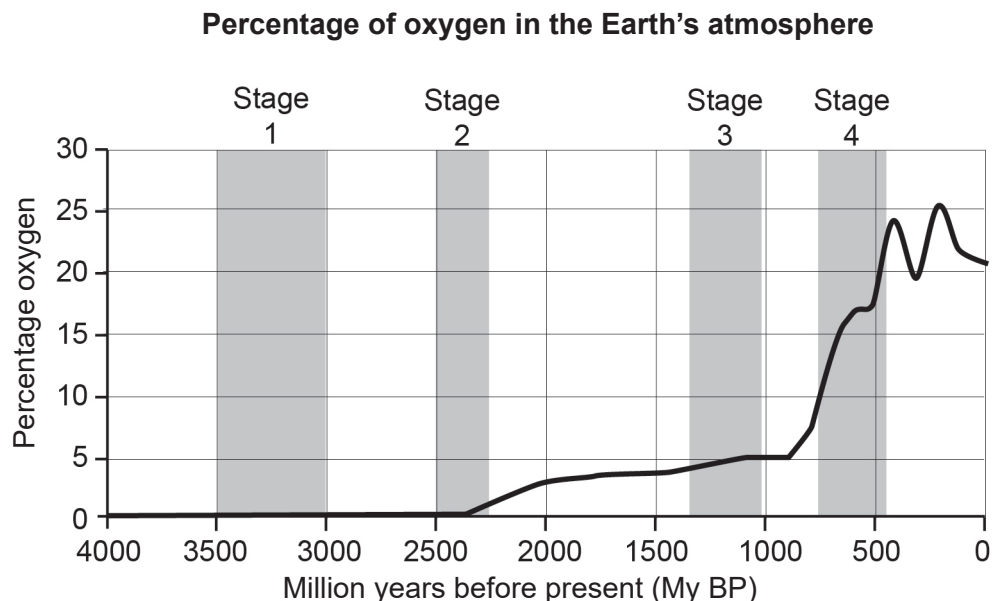
8. On the basis of the figure below illustrating plate tectonic behaviour, which of the following statements is correct?



- (a) Eruptions at location B are likely to be extremely explosive and hazardous.
- (b) Eruptions at location A produce pyroclastic flow hazards.
- (c) Lava flows are a significant hazard at location C.
- (d) Eruptions at location C produce the greatest impact on global climate.
9. Perth's citizens used an average of 127 000 litres of fresh water per person in 2015–2016. This was the highest rate of any city in Australia, and government policy in Western Australia is to encourage a reduction in domestic water use. One way of doing so is to
- (a) increase the output of desalination plants.
- (b) increase the recharge of groundwater aquifers.
- (c) limit the number of days when gardens can be watered.
- (d) reduce the amount of land clearing permitted.
10. Which of the following **best** explains a change in global weather that can be experienced in the months following a significant volcanic eruption?
- (a) an increase in temperature due to heat being released from the eruption
- (b) an increase in rainfall due to an increase in the presence of fine particles in the air
- (c) a decrease in rainfall due to an increased concentration of carbon dioxide in the atmosphere
- (d) a decrease in temperature due to an increase in the presence of particles in the stratosphere reflecting solar radiation
11. It is important for mining companies to use the topsoil removed during mining in the rehabilitation process because
- (a) it preserves the burrows of native animals.
- (b) it contains valuable mineral ore.
- (c) the topsoil contains seeds of native plant species.
- (d) it is cheaper than importing topsoil.

See next page

12. The graph below shows an estimate of the percentage of oxygen in the Earth's atmosphere over time.



- The majority of Australia's iron ore deposits were formed from banded iron formations. During which stage were **most** of the Australian banded iron formations produced?
- (a) Stage 1  
 (b) Stage 2  
 (c) Stage 3  
 (d) Stage 4
13. The hazard potential of a volcanic eruption is affected by the composition of magma. Which of the following magma compositions would have the highest hazard potential?
- (a) high silica, low volatiles  
 (b) low silica, high volatiles  
 (c) high silica, high volatiles  
 (d) low silica, low volatiles
14. During a fieldwork exercise, 30 students used geological compasses to collect strike and dip measurements from the same outcrop of dipping sedimentary layers. When they analysed their results back in the classroom, they found that their strike measurements varied from one another by up to 10°. Which of the following represents the **most** likely explanation for this variation?
- (a) irregularities in the measured bedding surface  
 (b) movement of Earth's magnetic pole during the field exercise  
 (c) changes in the temperature during the day  
 (d) the occurrence of a solar flare during the field exercise

15. Which of the following human activities does **not** contribute to the enhanced greenhouse effect?
- (a) farming
  - (b) electric power generation
  - (c) travel in jet aircraft
  - (d) passive solar heating

**End of Section One**

**See next page**

**Section Two: Short answer**

**55% (110 Marks)**

This section has **nine** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 100 minutes.

**Question 16**

**(11 marks)**

The Lachlan Fold Belt is a geological zone of folded and faulted metamorphic rocks extending from New South Wales and Victoria through to Tasmania. This fold belt contains two zones of metamorphic rocks, one consisting of rocks formed under high temperature and low pressure, and one consisting of rocks formed under low temperature and intermediate pressure.

- (a) For each of the metamorphic rock zones shown in the table below, name a rock that you might find in the zone and identify **one** characteristic of that rock. (4 marks)

<b>Metamorphic rock zone</b>	<b>Name of rock</b>	<b>Characteristic of the rock</b>
High temperature, low pressure		
Low temperature, intermediate pressure		

- (b) Identify **two** changes that can be caused in metamorphic rock textures by increasing pressure and/or temperature. (2 marks)

One: \_\_\_\_\_

\_\_\_\_\_

Two: \_\_\_\_\_

\_\_\_\_\_



Granites are also found within the Lachlan Fold Belt. The intrusion of these granites is commonly observed to have produced another distinctive type of metamorphism in the rocks of the surrounding country.

- (c) (i) Name this type of metamorphism. (1 mark)

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- (ii) Describe how you could distinguish between this type of metamorphism and the effects of regional metamorphic processes. (2 marks)

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A dehydration reaction is a chemical reaction that results in a mineral releasing water.

- (iii) Describe how the water released in dehydration reactions can lead to the formation of mineral resource deposits. (2 marks)

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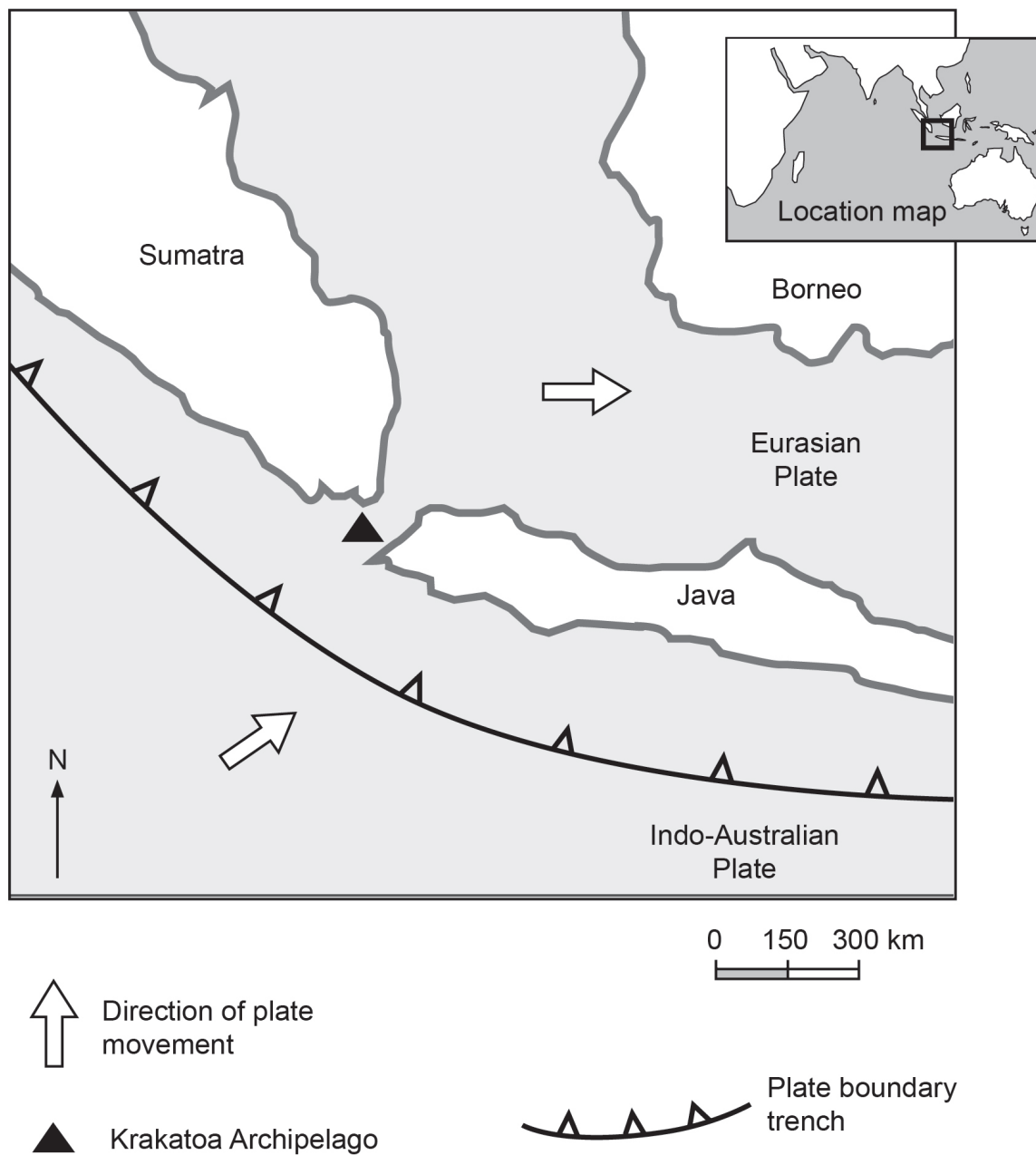
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Question 17

(13 marks)

The Krakatoa Archipelago is located between Java and Sumatra and has a long history of explosive eruptions, including a dramatic 1883 eruption in which a column of ash was thrown 20 km into the atmosphere and disrupted global weather patterns for years. In December 2018, the island volcano Anak-Krakatoa ('Child of Krakatoa') erupted, causing a tsunami that killed hundreds of people.



- (a) Explain the tectonic processes responsible for the formation of these volcanoes and show the tectonic setting of this area on a labelled cross-sectional sketch. (5 marks)

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**Question 17** (continued)

Anak-Krakatoa is believed to have caused the 2018 tsunami by producing a large underwater landslide that was triggered by its eruption.

- (b) Explain how tsunamis can also be caused by another tectonic process in the absence of volcanism. (4 marks)

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- (c) Explain **one** way in which local or global weather patterns might be affected if an eruption similar to the 1883 Krakatoa event occurred today. (4 marks)

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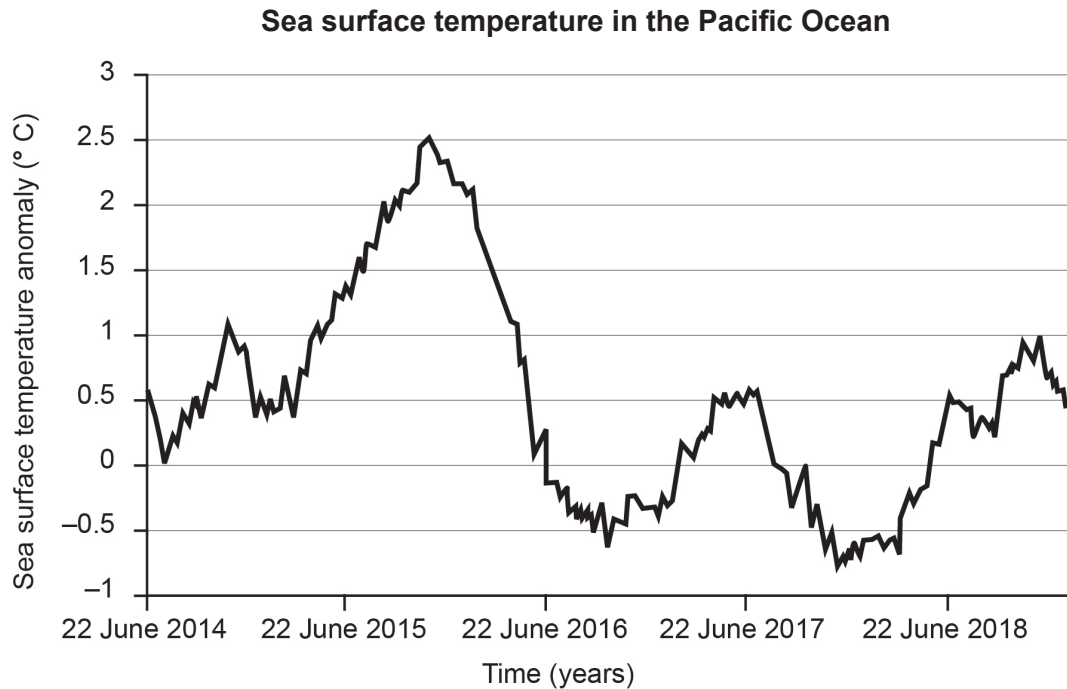
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## Question 18

(14 marks)

In January 2019, climate models produced by the Australian Bureau of Meteorology suggested that the immediate impacts of El Niño had passed, but there was a risk of it returning during the autumn of 2019. The graph below shows the sea surface temperature in the Pacific Ocean over recent years.



- (a) Draw a circle on the graph to identify a period when El Niño conditions would have been experienced. (1 mark)
- (b) In the space below, draw a labelled diagram showing the oceanic and atmospheric conditions in the Pacific Ocean between Australia and South America during an El Niño event. (5 marks)

**Question 18** (continued)

- (c) Identify **two** impacts of an El Niño event on weather conditions in eastern Australia. (2 marks)

One: \_\_\_\_\_

\_\_\_\_\_

Two: \_\_\_\_\_

\_\_\_\_\_

- (d) Explain **two** ways in which a forecast of El Niño conditions for the coming season could be used by farmers in eastern Australia to manage their activities. (6 marks)

One: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Two: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

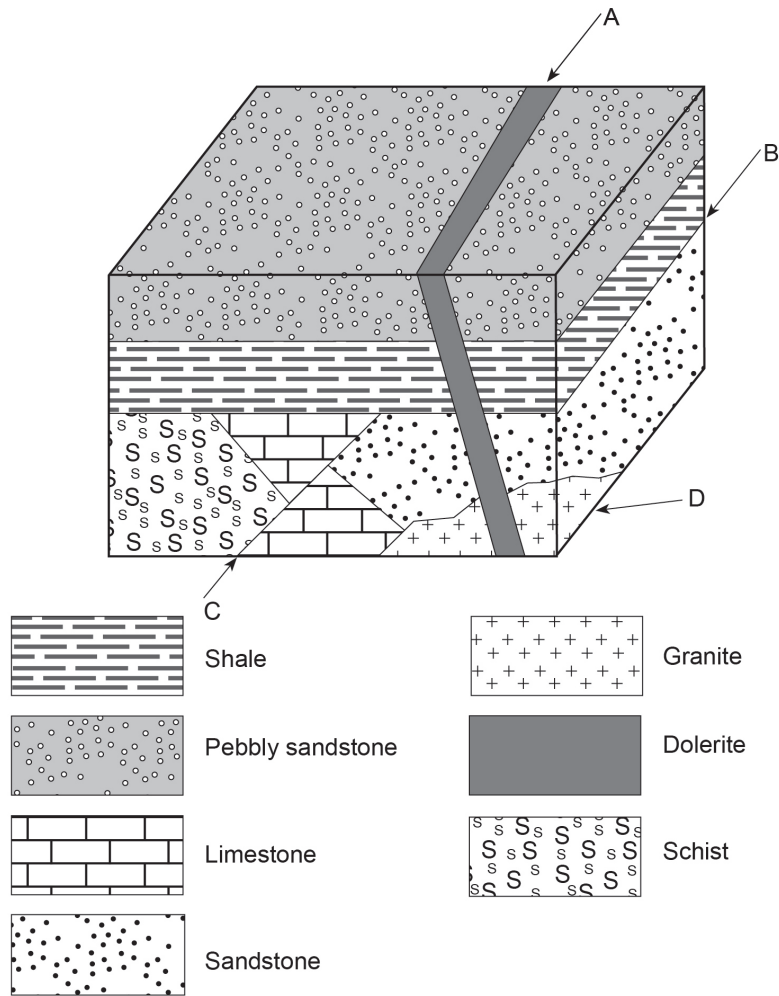
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Question 19

(12 marks)

Drill data and structural mapping have been used to produce the following block diagram illustrating the geology of an area.



(a) On the basis of the relationships shown in this diagram, name the geological structures marked as A, B, C, and D. (4 marks)

- A: \_\_\_\_\_
- B: \_\_\_\_\_
- C: \_\_\_\_\_
- D: \_\_\_\_\_

(b) Identify the oldest sedimentary rock and the youngest igneous rock present in the region. (2 marks)

- Oldest sedimentary rock: \_\_\_\_\_
- Youngest igneous rock: \_\_\_\_\_

**Question 19** (continued)

(c) Outline a geological process that can account for each of the following observations about the geology of the area shown in the block diagram on page 15.

(i) Geological data obtained from analysis of rock samples from this region have shown a large age difference between the sandstone and the overlying shale. (2 marks)

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(ii) The limestone is predominantly fine-grained and composed of shell fragments and microfossils, but where it is in contact with the granite, it has a crystalline, sugary texture and no recognisable fossil material. (2 marks)

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(iii) Chemical analysis indicates that the schist is derived from a sedimentary rock with a substantial biological component, but the unit contains no fossils today. (2 marks)

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## Question 20

(12 marks)

Atmospheric carbon dioxide (CO<sub>2</sub>) levels have been increasing significantly during the last hundred years. The combustion of fossil fuels such as oil, natural gas and coal is the major contributor to this increase. The graph below shows global carbon emissions produced by fossil fuel sources from 1900–2014.

Global carbon emissions from fossil fuels, 1900–2014



- (a) This graph shows a sharp increase in carbon emissions from fossil fuel use since the 1940s. Identify **two** possible reasons for this increase. (2 marks)

One: \_\_\_\_\_

\_\_\_\_\_

Two: \_\_\_\_\_

\_\_\_\_\_

- (b) Fossil fuel use is not the only cause of increasing atmospheric CO<sub>2</sub> levels. Describe **one** other human activity that is a significant source of CO<sub>2</sub> emissions. (2 marks)

\_\_\_\_\_

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See next page

**Question 20** (continued)

Increasing global atmospheric CO<sub>2</sub> levels are contributing to the disruption of Earth's natural climate equilibrium through a process commonly referred to as the 'enhanced greenhouse effect'.

- (c) With the aid of a diagram, explain how the enhanced greenhouse effect influences global temperatures. (4 marks)

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- (d) Identify **two** possible consequences of increased global temperatures and **one** effect of each on human society. (4 marks)

One: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Two: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Question 21**

**(11 marks)**

Western Australia's economy benefits greatly from the mining of mineral and energy resources including gold, iron ore, nickel and natural gas. The discovery of such mineral or energy deposits does not guarantee that they will be developed into a working mining operation. The decision as to whether and how to extract a resource depends on a large number of factors.

- (a) Describe **two** ways in which the geographic location of a resource could influence a decision about whether or not to mine it. (4 marks)

One: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Two: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (b) Describe how the method used for the extraction of a mineral or energy deposit could be influenced by the: (4 marks)

concentration of the resource.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

physical distribution of the resource.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- (c) Explain why the government requires mining companies to consult and/or negotiate with local communities in assessing the viability of a potential mine. (3 marks)

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**Question 22**

**(13 marks)**

The plate tectonic super-cycle refers to a natural process by which Earth alternates between a single continent with a single ocean (such as Pangaea and the corresponding Panthalassan Ocean) to a number of distributed continents and oceans. The long-term geological record shows that this cycle operates on a timescale of 400 to 600 million years, and is one of the major factors in long-term climatic change.

- (a) Describe how the amalgamation or breakup of continents during the super-cycle might affect oceanic currents and the impact of these changes on global climate. (4 marks)

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The plate tectonic super-cycle changes the number and location of mountain ranges around the globe.

- (b) Explain **two** ways in which mountain ranges or other changes caused by plate movement can affect the climate of a continent. (6 marks)

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Scientists are continuously changing the models that they present in order to explain Earth's history, including the understanding of long-term climate change. A similar observation can be made for all areas of scientific study.

- (c) Explain why scientific models are continuously being replaced or updated. (3 marks)

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**Question 23**

**(11 marks)**

Many human activities change (either directly or indirectly) the natural balance of the Earth's ecosystems.

- (a) For **one** specific ecosystem you have studied, describe **two** ways in which human activities have changed or could potentially change the ecosystem. (4 marks)

Ecosystem name: \_\_\_\_\_

One: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Two: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- (b) Describe **two** ways in which scientists have gathered or could potentially gather information to assess the extent of change to an ecosystem. (4 marks)

One: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Two: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



- (c) Explain how scientific data collected on ecological change could be used to ensure that human activity is conducted in a more environmentally sustainable manner. (3 marks)

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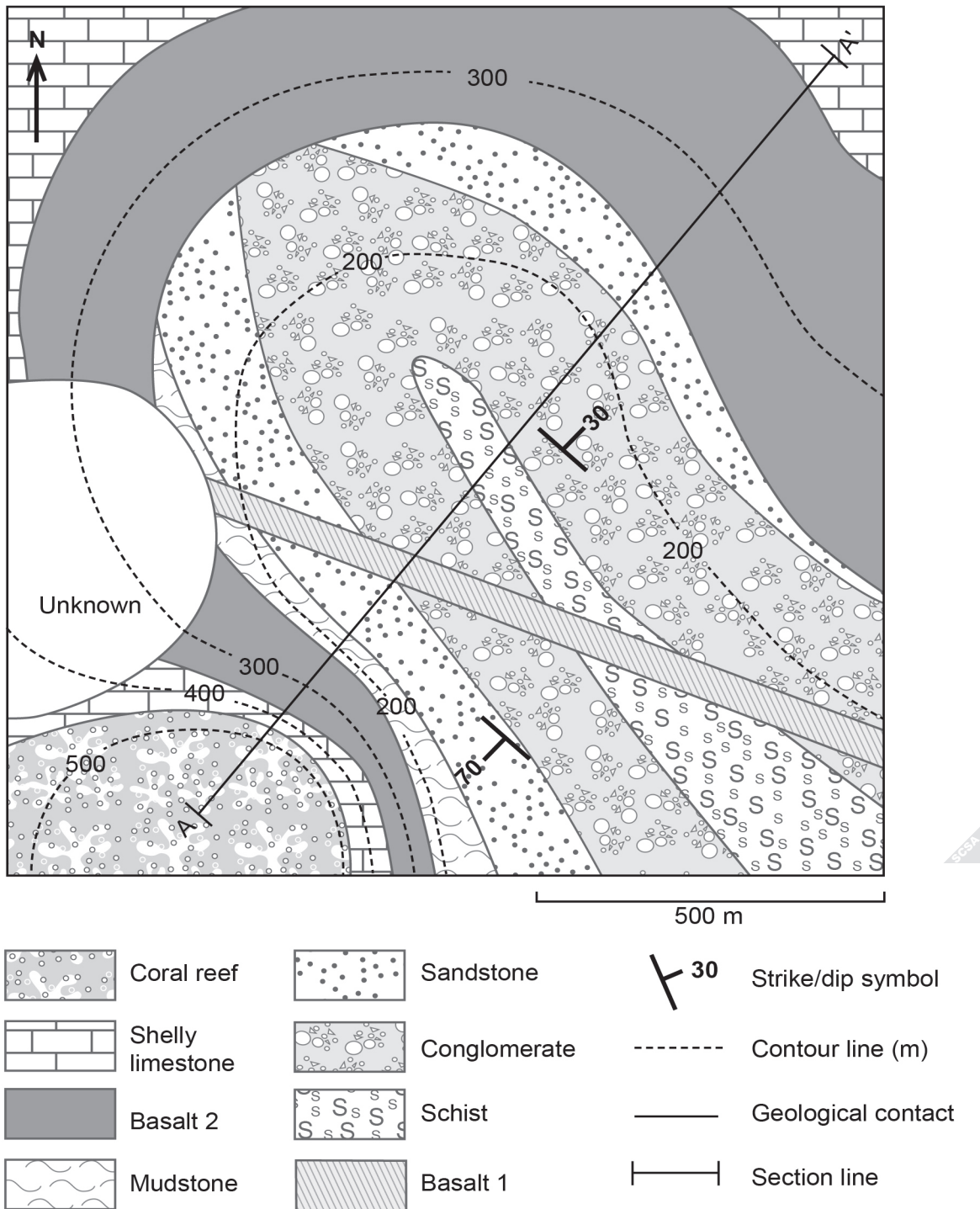
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Question 24

(13 marks)



See next page

- (a) Construct a cross-section of the region along the line A-A' on the section line provided below. Show the actual or inferred distribution of all lithologies cutting this section line down to 100 metres below sea level. Note: to assist you in transcribing data locations, you may remove page 45 by tearing along the perforations. (7 marks)



A spare section line is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt.

It is not known whether basalt 1 feeds into or is older or younger than basalt 2, and the part of the area where this relationship could be tested has not been mapped.

- (b) Mark an **X** on the map on page 26 where you predict the contact between basalts 1 and 2 might be exposed. (1 mark)

**Question 24** (continued)

(c) If this contact is exposed, describe or sketch the relationship you would see between basalt 1, basalt 2 and the shelly limestone if:

(i) basalt 1 feeds into basalt 2. (2 marks)

(ii) basalt 1 is younger than basalt 2. (2 marks)

A company exploring this region for minerals has found significant gold mineralisation where basalt 1 cuts the contact between the conglomerate and schist units. The company wants to test whether this mineralisation extends below the surface but it can only afford one vertical drillhole.

(d) Mark a **Y** on the map on page 26 where your cross-section predicts a vertical hole would encounter this feature of interest. (1 mark)

**End of Section Two**

**See next page**

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**See next page**

**Section Three: Extended answer**

**30% (30 Marks)**

This section contains **three** questions. You must answer **two** questions: the compulsory question (Question 25) and **one** of the other questions (Question 26 or Question 27). Write your answers on the pages provided following Question 27.

If you use a page for planning, indicate this clearly at the top of the page.

Suggested working time: 60 minutes.

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**Question 25**

**(15 marks)**

You work for an organisation that provides advice on earthquake hazards. You have been approached by a multinational hotel company that is in the process of building a new beachfront resort on an island in Indonesia. The island is covered in steep hills and tropical jungle, and has previously been uninhabited. During initial excavation work for the resort, the company's construction engineers uncovered a previously-unknown fault structure through the middle of the planned resort site. The company is concerned about the risks this may pose to its plans.

- (a) On the basis of the information with which you have been provided regarding the site, identify **three** different hazards that an earthquake on this fault structure could pose for the resort and its guests. (3 marks)

The hotel company is delaying its development to investigate the specific risks this fault might pose.

- (b) Identify **two** types of data that you could research and describe how these could be used to determine the frequency and magnitude of earthquakes that have occurred on this fault structure in the past. (6 marks)
- (c) Write a hazard mitigation report for the company explaining **two** measures it could take in the construction or operation of its resort facilities to reduce the risk posed to its guests by this fault structure. (6 marks)

**Question 26****(15 marks)**

There is an enormous demand for energy in Australia. Non-renewable resources, such as coal, oil and natural gas, are currently the dominant sources of this energy. This reliance on non-renewable resources is not sustainable and in the long term, society will need to replace much of this resource use with energy derived from renewable resources, such as solar, wind, hydroelectric, geothermal and organic matter (biomass).

For **one** renewable resource:

- (a) (i) state why the resource can be considered to be renewable. (1 mark)
- (ii) describe how energy is produced from this resource and stored and/or transferred. (4 marks)
- (b) Describe **two** environmental factors that are important in selecting a suitable location for the production of this resource. (4 marks)
- (c) Explain **two** factors that affect the cost effectiveness of using this resource. You may consider economic, environmental or political factors in your answer. (6 marks)

**or**

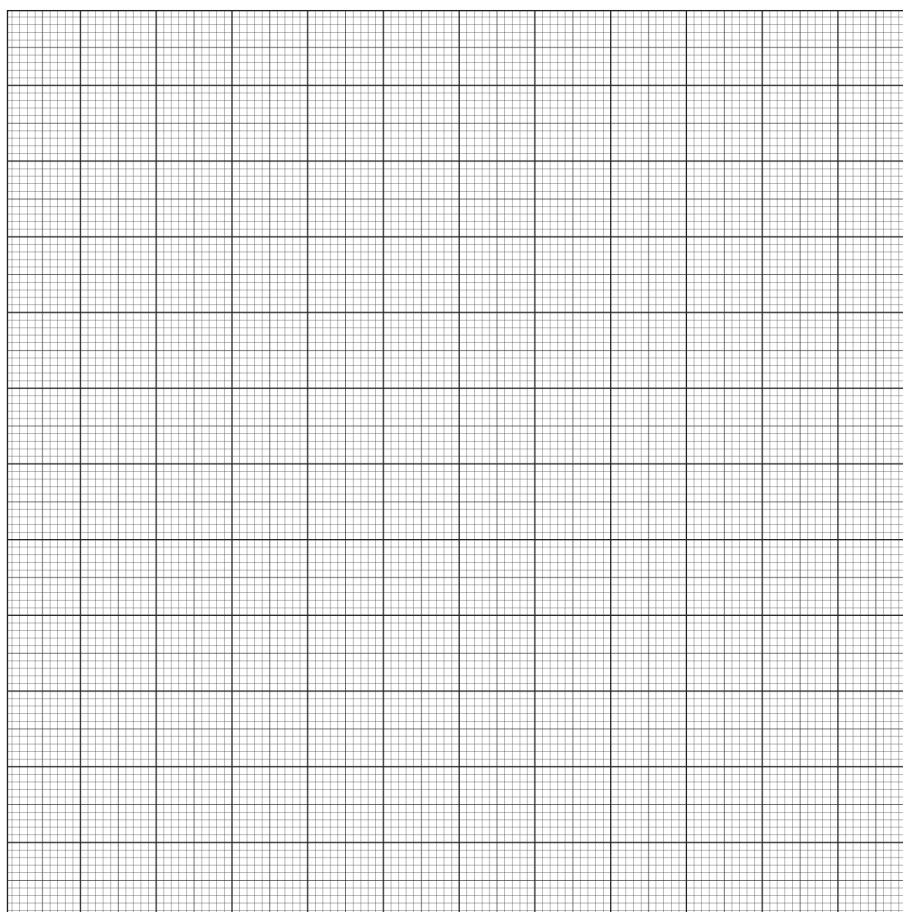
**Question 27**

**(15 marks)**

The geophysical survey team from a mining company has conducted a geomagnetic survey of a region within an existing mining lease that they believe may contain economic mineralisation. The results were recorded in terms of Total Magnetic Intensity, which relates to the magnetic properties of geological features.

The figure on page 33 is a map of the mining lease, showing one of the transects along which geomagnetic measurements were taken. The measurements made along this transect are recorded in the accompanying table. You have been given the task of analysing the geomagnetic data collected across this transect.

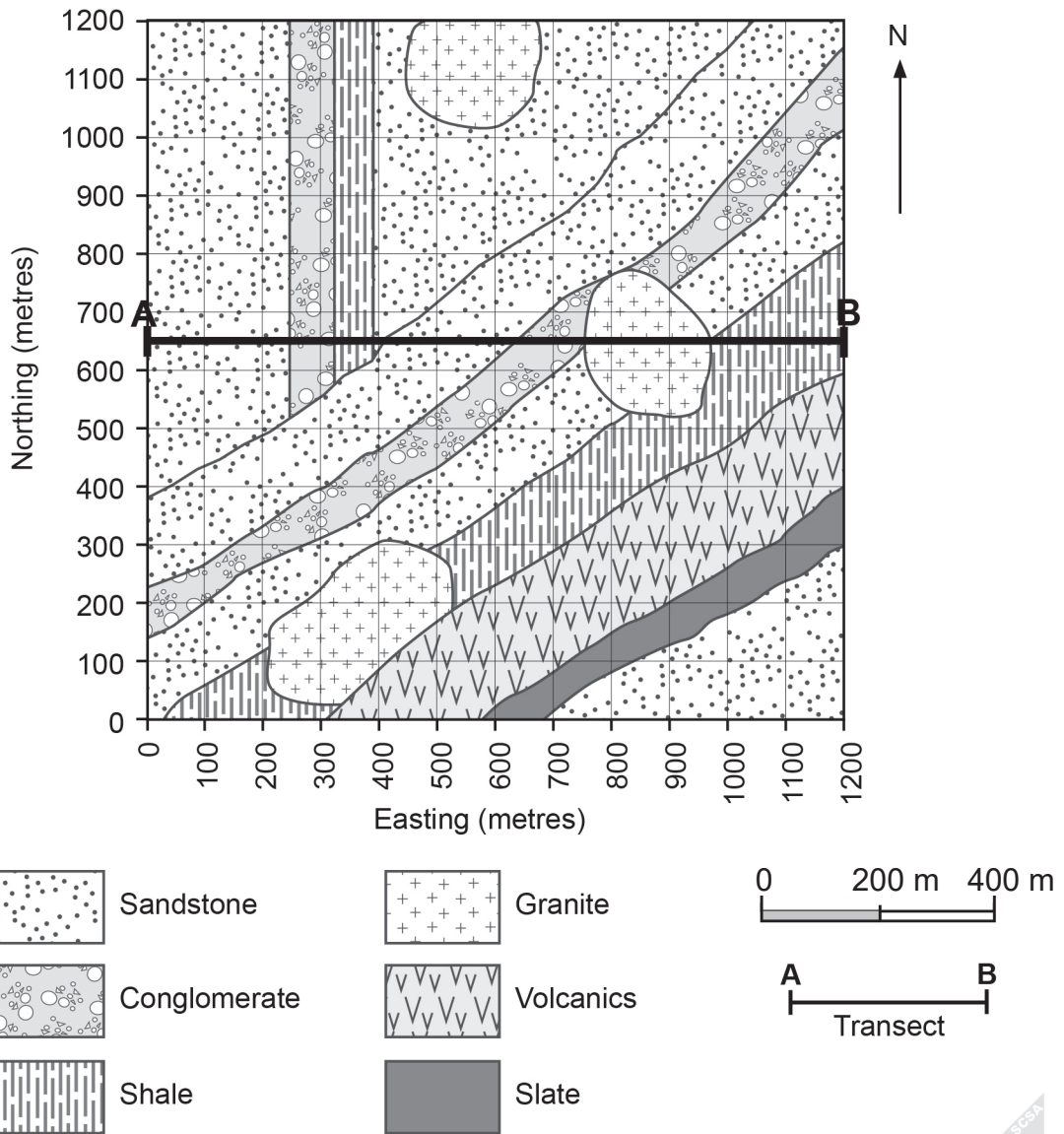
- (a) On the grid provided below, draw a line graph of the total magnetic intensity recorded along the transect A-B. (5 marks)
- (b) State the location in eastings and identify the target lithology where you would undertake further exploration. Outline **two** reasons for your decision. (4 marks)
- (c) Describe **two** other suitable exploration techniques that could help you to refine the location of the mineral resource that you believe may be present at this site. Outline the response you would expect from each technique. (6 marks)



A spare grid is provided at the end of the Question/Answer booklet. If you need to use it, cross out this attempt.

**See next page**





Easting	Total Magnetic Intensity (nT)
0	10
100	10
200	30
300	50
400	100
500	300
600	550
700	560
800	570
900	450
1000	50
1100	10
1200	10

End of questions

























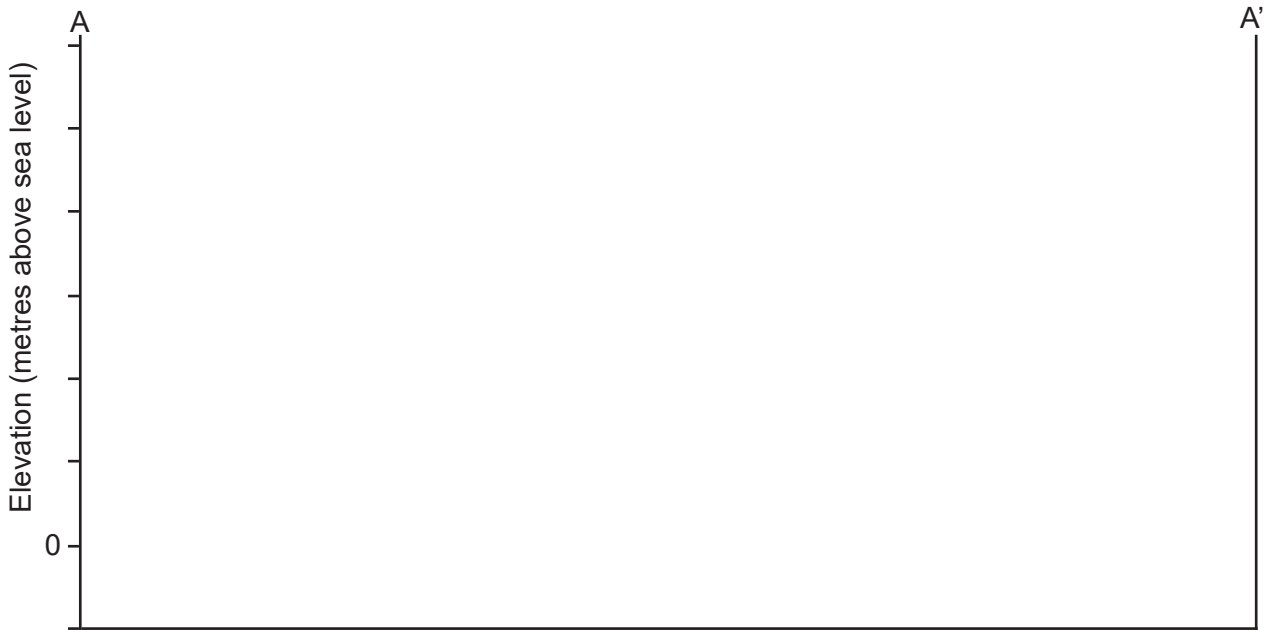
You may tear along the perforations to use this page (to transcribe strata locations for Question 24).

**This page is to be used for transcribing strata locations only**

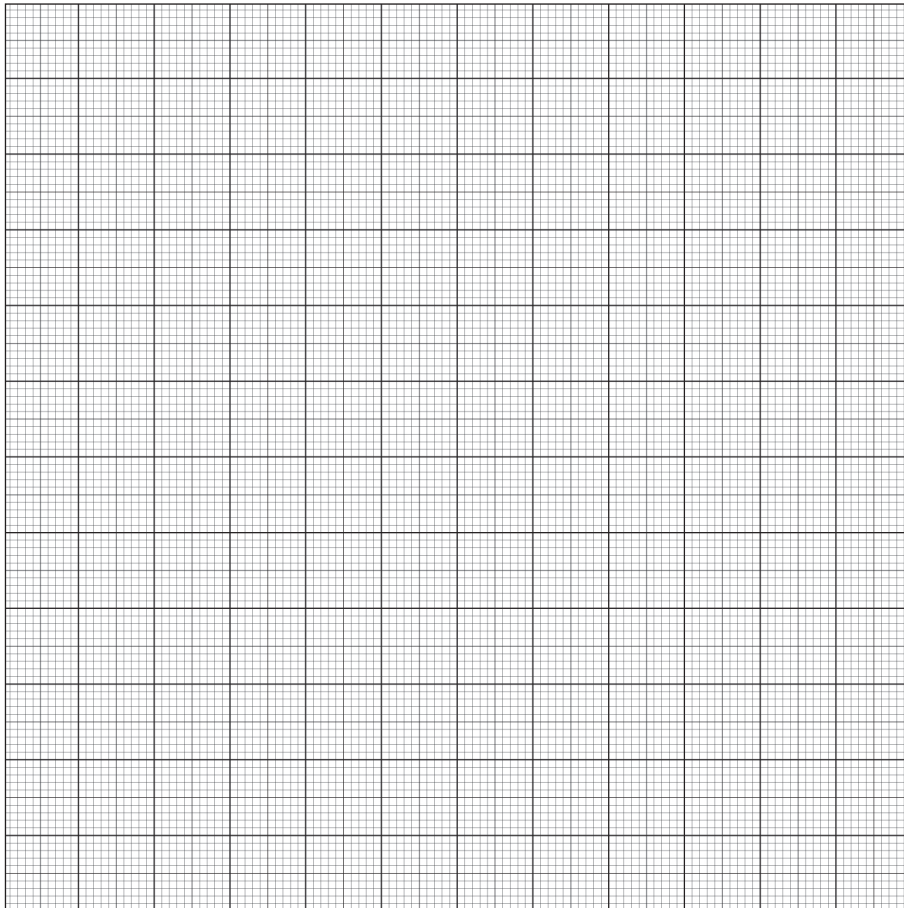
You may tear along the perforations to use this page (to transcribe strata locations for Question 24).

**This page is to be used for transcribing strata locations only**

Spare section line



Spare grid



## ACKNOWLEDGEMENTS

- Question 1** First and second sentence adapted from: Gornitz, V. (2007). *Sea level rise, after the ice melted and today*. Retrieved May, 2019, from [https://www.giss.nasa.gov/research/briefs/gornitz\\_09/](https://www.giss.nasa.gov/research/briefs/gornitz_09/)
- Question 2** First and second sentence information from: Skates, L. (2014, August 20). *Swan and Canning Rivers: auditor-general's report [...] in Perth waterways*. Retrieved May, 2019, from <https://www.abc.net.au/news/2014-08-13/spotlight-on-the-health-of-the-swan-river/5668056>
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