



Western Australian Certificate of Education ATAR course examination, 2016

Question/Answer booklet

EARTH AND ENVIRONMENTAL SCIENCE

Please place your student identification label in this box

Student number: In figures

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In words

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	10	10	100	110	55
Section Three Extended answer	3	2	60	30	30
Total					100

Instructions to candidates

1. The rules for the conduct of the Western Australian Certificate of Education ATAR course examinations are detailed in the *Year 12 Information Handbook 2016*. 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. 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. Additional working space pages at the end of this Question/Answer booklet are for planning or continuing an answer. If you use these pages, indicate at the original answer, the page number it is planned/continued on and write the question number being planned/continued on the additional working space page.
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. 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.

1. During fieldwork, a student used a geological compass to collect a set of strike and dip measurements from dipping sedimentary layers. Which of the following represents a possible source of measurement error in her measurements?
 - (a) variation of the Earth's magnetic field over time
 - (b) gravity waves resulting from the merging of two black holes
 - (c) irregularities in the measured bedding surfaces
 - (d) a solar magnetic storm

2. Sulfur dioxide and particulate matter introduced into the stratosphere by industrial activity
 - (a) do **not** affect the overall temperature of the atmosphere.
 - (b) reduce the overall temperature of the atmosphere.
 - (c) increase the overall temperature of the atmosphere.
 - (d) increase the level of UV radiation reaching the surface of the Earth.

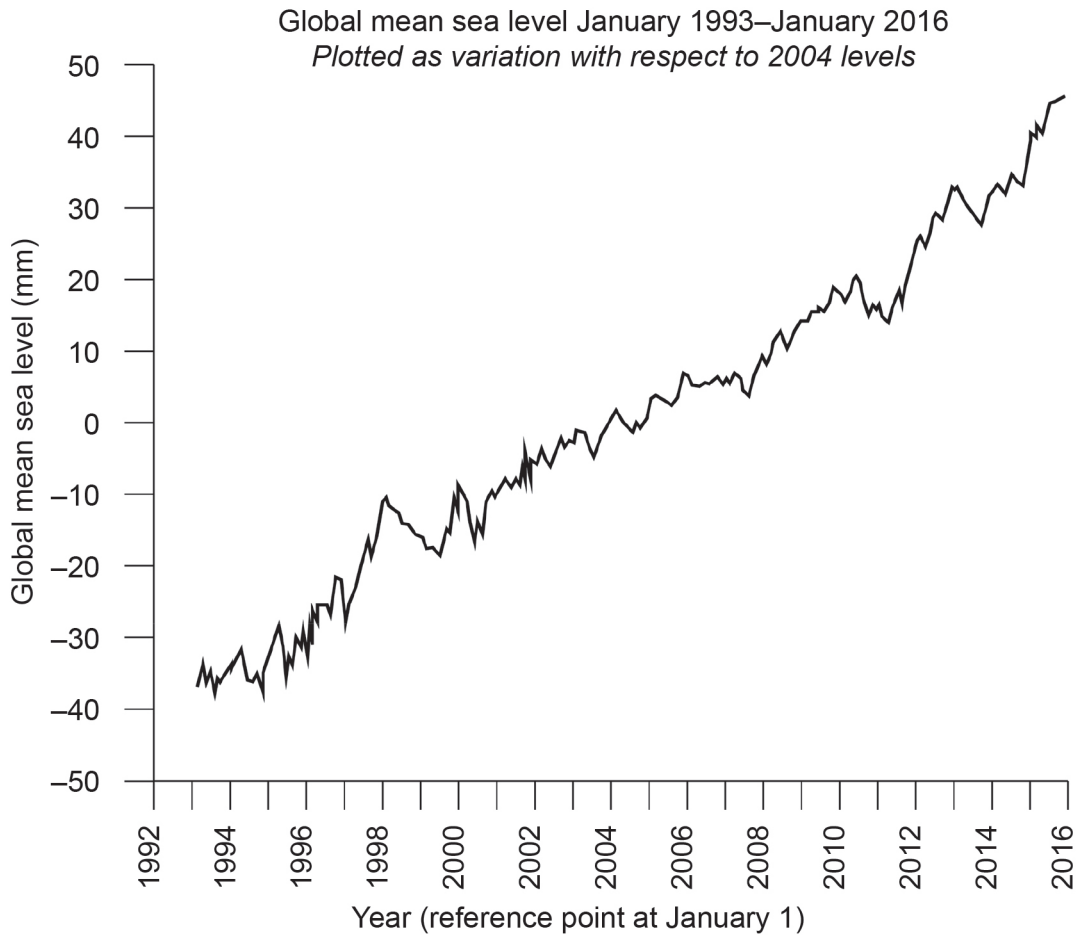
3. In many parts of the world, highly-productive agriculture is carried out on flood plains where rivers sometimes inundate the farmland. The advantage of the floods to farmers is that flood water
 - (a) drowns pests that would otherwise eat their crops.
 - (b) flushes away waste products left on the ground by farm animals.
 - (c) provides a valuable source of clean, fresh drinking water.
 - (d) leaves behind a sediment layer rich in nutrients when the floods recede.

4. Which of the following natural processes does **not** contribute to changes in the global climate over time?
 - (a) fluctuations in the energy released by the Sun
 - (b) variations in the orbit of the Earth around the Sun
 - (c) changes in the mixture of gases in the atmosphere
 - (d) variations in the distance between the Earth and the Moon

See next page

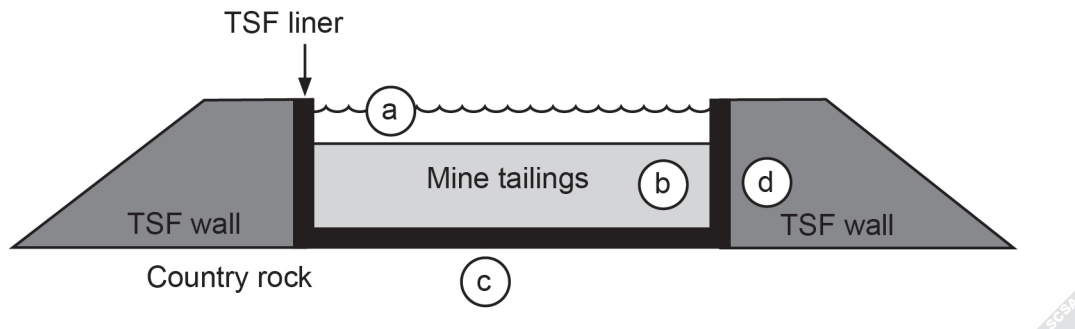
5. Many types of geological and historical evidence can be used to show how climatic conditions change over time. Which of the following is **not** commonly used for this purpose?
- (a) ice core data
 - (b) marine fossils
 - (c) pollen
 - (d) seismic reflection
6. In which of the following tectonic environments would the generation of a tsunami be **most** common?
- (a) mid-oceanic ridge
 - (b) subduction zone
 - (c) continental rift zone
 - (d) transform boundary
7. Which of the following gases is **least** likely to be found in volcanic emissions?
- (a) carbon dioxide (CO₂)
 - (b) water vapour (H₂O)
 - (c) oxygen (O₂)
 - (d) sulfur dioxide (SO₂)
8. Many active volcanoes are monitored intensively to assess risk to nearby settlements. Which of the following could indicate that a volcano is about to erupt?
- (a) an increased number of shallow earthquakes centred beneath the volcano
 - (b) unusually heavy rainfall over the volcano
 - (c) the sudden disappearance of migratory birds from the area around the volcano
 - (d) the detection of fluorine in the drinking water of a settlement near the volcano
9. Which of the following strategies would **best** allow a society to increase the volume of usable fresh water?
- (a) planting native vegetation along water courses
 - (b) constructing a desalination plant
 - (c) fluoridating reservoir waters
 - (d) regulating the disposal of industrial wastes
10. Compared with other potential energy sources, a disadvantage of the use of geothermal heat in power generation is its
- (a) high running costs.
 - (b) high initial costs.
 - (c) elevated levels of greenhouse gas emissions.
 - (d) need for large areas of land.

11. The graph below shows global mean sea level measured by satellite observation between 1993 and 2016.



- Which of the following statements can be shown to be correct using only the data displayed on this graph?
- (a) Sea level has risen and fallen over the observed period, but has remained unchanged overall.
- (b) Global mean sea level is at the highest point it has ever been in Earth's history.
- (c) Sea level has risen every year since 2010.
- (d) Sea level in January 1999 was lower than it had been in January 1998.
12. Which of the following lists is made up entirely of resources that could be managed on a sustainable basis if extracted with appropriate monitoring and control?
- (a) rock lobster, pine forests, geothermal energy, ground water
- (b) rainwater, sharks, geothermal energy, shale gas
- (c) sunlight, wheat, bauxite, heavy mineral sands
- (d) wind, copper, karri timber, marron (freshwater crayfish)

13. The diagram below shows a cross-section through a tailings storage facility (TSF) constructed to contain mine waste and prevent it from contaminating the local water table.



- Which would be the **best** location among those indicated in the diagram from which to collect a sample to test for leakage of the TSF?
- (a) within the waste water contained in the TSF
 (b) from the mine waste that has settled out of water onto the floor of the TSF
 (c) in the country rock beneath the TSF
 (d) within the material making up the retaining wall or embankment of the TSF
14. Which of the following represents a potential positive impact of bushfires on the Australian environment?
- (a) increased soil erosion
 (b) local extinction of burrowing marsupials
 (c) enhanced seed production and germination by native plants
 (d) increased moisture levels in the subsoil from fire-fighting activity
15. The concept of an 'ecological footprint' is a key element of modern resource management. Which of the following **best** defines the ecological footprint of a mine site?
- (a) all resources used in producing, harvesting, transporting and processing the extracted commodity, and in treating or eliminating the associated waste products
 (b) the physical land area occupied by the mined ore body
 (c) the native ecosystems disturbed or displaced by resource extraction and processing
 (d) the CO₂ equivalent released by resource extraction operations and associated transport and activities

End of Section One

See next page

Section Two: Short answer**55% (110 Marks)**

This section has **10** questions. Answer **all** questions. Write your answers in the spaces provided.

Additional working space pages at the end of this Question/Answer booklet are for planning or continuing an answer. If you use these pages, indicate at the original answer, the page number it is planned/continued on and write the question number being planned/continued on the additional working space page.

Suggested working time: 100 minutes.

Question 16**(11 marks)**

The exploration and evaluation of new mineral deposits is a complex, multi-stage process. Initial exploration commonly uses techniques such as geological mapping, interpretation of satellite images and aerial photographs, and the application of geophysical and geochemical methods. Once a mineral deposit is discovered, further geological, economic, social and environmental evaluation is required to assess the viability of mining the resource.

- (a) For **one** mineral exploration technique, outline how the method is applied in the search for mineralised rocks, and describe the response the method would give if mineralisation was present in the surveyed area. (4 marks)

Question 16 (continued)

- (b) For an area where mineralisation has been located, outline a program of further investigation that could assess the size and grade of the newly-discovered mineral deposit. (3 marks)

- (c) Other than the type of mineralisation present, describe **two** factors that would need to be considered before a decision to mine the resource could be made. (4 marks)

Question 17

(10 marks)

In the early summer of 2015–2016 a number of severe bushfires caused extensive damage to both natural and human-made environments in southern parts of Western Australia, South Australia, Victoria and Tasmania.

- (a) Various methods are used to reduce the risk of damage to property such as housing and farm buildings in areas where bushfires are a likely occurrence. Name **one** such method and explain how it can reduce the risk of damage from bushfires. (2 marks)

- (b) Climate records show that the regions affected by these bushfires had experienced some of the lowest winter rainfall ever in 2015. Suggest **two** reasons why the very dry winter may have contributed to the number and severity of the fires. (2 marks)

Question 17 (continued)

- (c) Local weather conditions can influence the spread of bushfires. Name **two** weather conditions that can enhance the spread of bushfires, and describe briefly how each causes this effect. (4 marks)

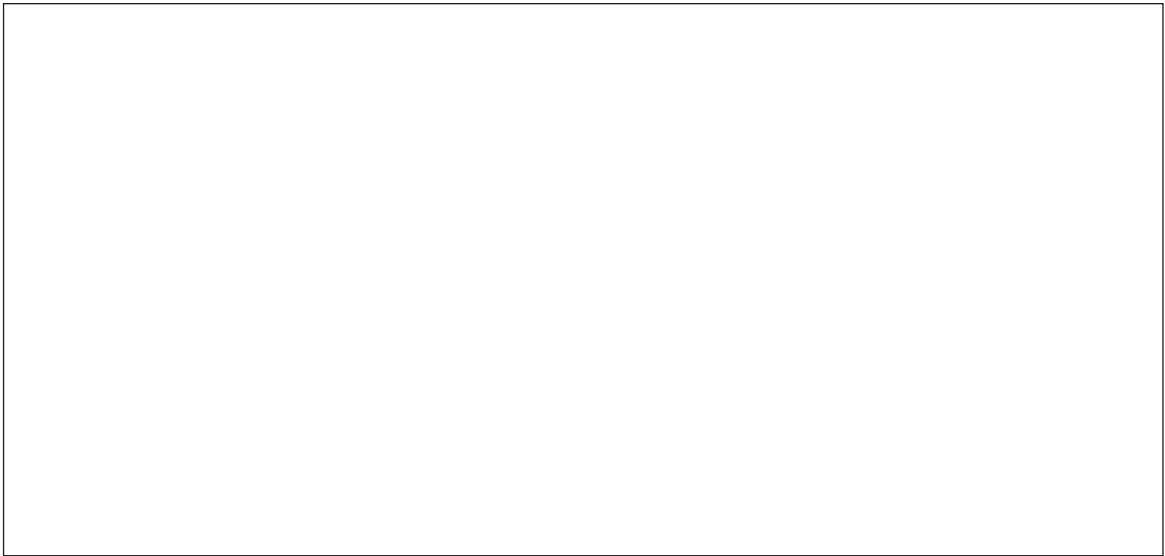
- (d) In many parts of Australia, natural vegetation that has been severely damaged by bushfires is able to regenerate quickly. Describe an adaptation found in Australian plants that enables them to achieve this rapid regrowth. (2 marks)

Question 18

(10 marks)

Scientists have been able to relate periodic changes in the long-term pattern of rainfall and temperature across much of Australia to changes in the distribution of heat in the Pacific Ocean and air pressure and wind flow over the ocean. Two distinct patterns of such disruption of normal circulation patterns have been recognised – La Niña and El Niño.

- (a) In the space below, draw a diagram that represents the Pacific Ocean system during a La Niña event. On your diagram, show the location of Australia, the distribution of the warmest water in the ocean, the horizontal flow of air (wind), and the vertical movement of air. (3 marks)



- (b) In some areas of tropical Australia, the removal of native vegetation and intensive farming leave soils vulnerable to erosion. Flooding in such areas can affect coastal waters and damage coastal marine life, including corals. Describe **two** different ways in which sediment-laden runoff can damage marine life. (4 marks)

Question 18 (continued)

- (c) Heavy rainfall in inland regions that are normally very dry can have a significant impact on the abundance and distribution of plants and animals. Discuss an example of the way in which plant **or** animal life in arid regions of Australia responds to periods of high rainfall. (3 marks)

Question 19

(12 marks)

To investigate changes in the temperature of the Earth's atmosphere, scientists integrate data from thousands of weather recording stations to calculate a single global average surface temperature for each year. A selection of such data is shown below in Table A.

Year	1880	1900	1920	1940	1960	1980	2000	2010
Temperature (°C)	13.6	13.7	13.75	14.08	14	14.2	14.4	14.9

Table A: Global average surface temperature in selected years from 1880 to 2010

- (a) Describe **two** trends apparent in temperature change over time in these data. (2 marks)

- (b) The data collected after 1880 were recorded on well-calibrated, standardised scientific instruments. To study and describe earlier climatic conditions, scientists have used other methods. Name and describe **one** method used to obtain evidence of climatic conditions on Earth that pre-date the development of instrumental measurement. (3 marks)

Question 19 (continued)

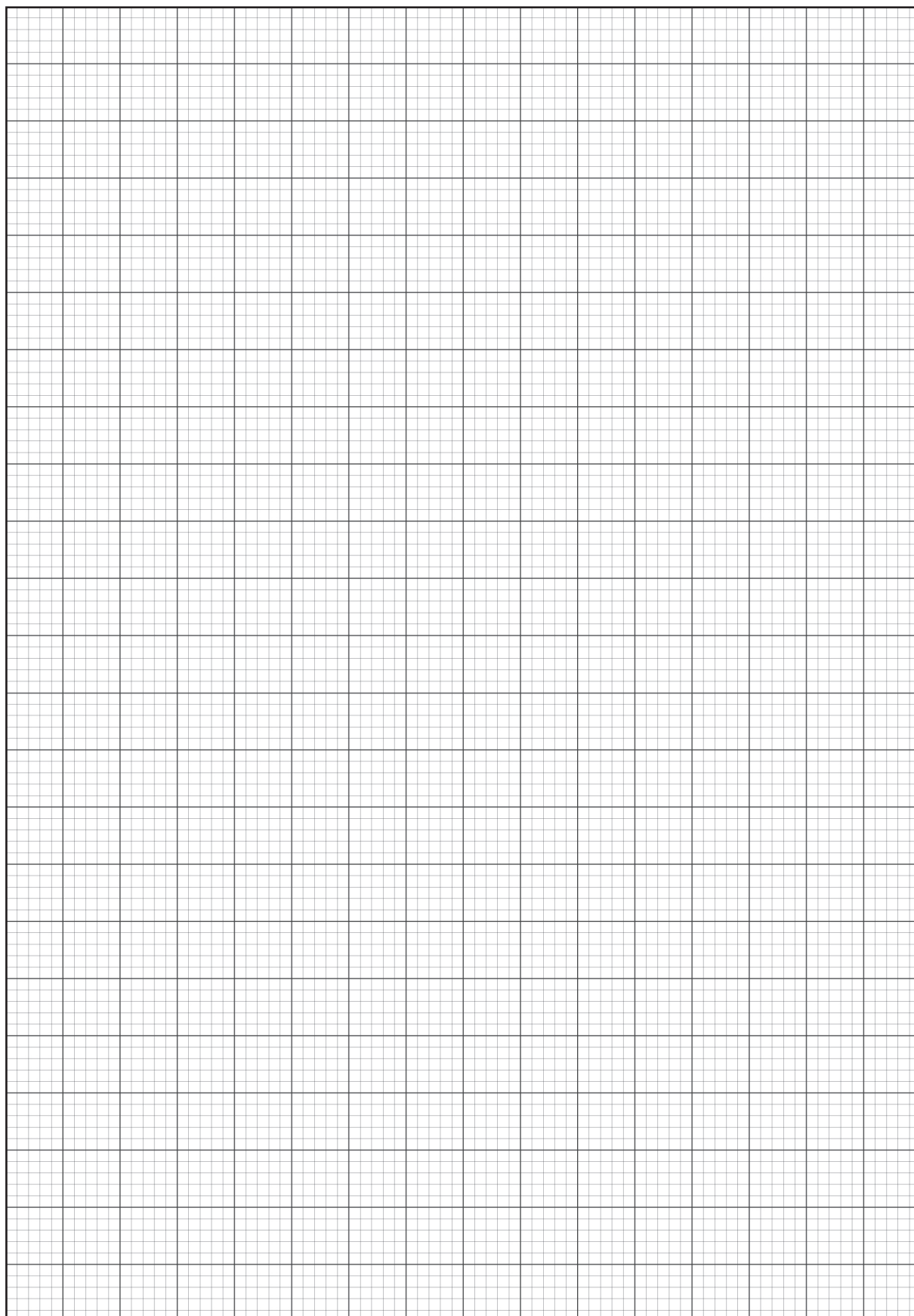
Table B presents more detailed data on changes in global average surface temperature for the period from 2001 to 2015.

Year	2001	2003	2005	2007	2009	2011	2013	2015
Temperature (°C)	14.84	14.91	14.94	14.89	14.96	14.82	14.9	15.15

Table B: Global average surface temperature in selected years from 2001 to 2015

- (c) Using the grid provided on the page opposite, draw a line graph of the data shown in Table B. (5 marks)

- (d) Assuming no changes in the factors that now affect the temperature of the atmosphere, use the data in Table A on page 13 and Table B above to predict the change in the average global temperature between 2015 and 2035. Explain your reasoning. (2 marks)



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

See next page

Question 20

(11 marks)

Human activities can have a number of detrimental effects on the quality of the Earth's limited freshwater sources. One such negative effect is eutrophication of a water system.

- (a) Describe **one** way in which human activity could lead to eutrophication of rivers.

(3 marks)

- (b) Describe **one** potential consequence of eutrophication for plants and **one** potential consequence to animal life within affected rivers.

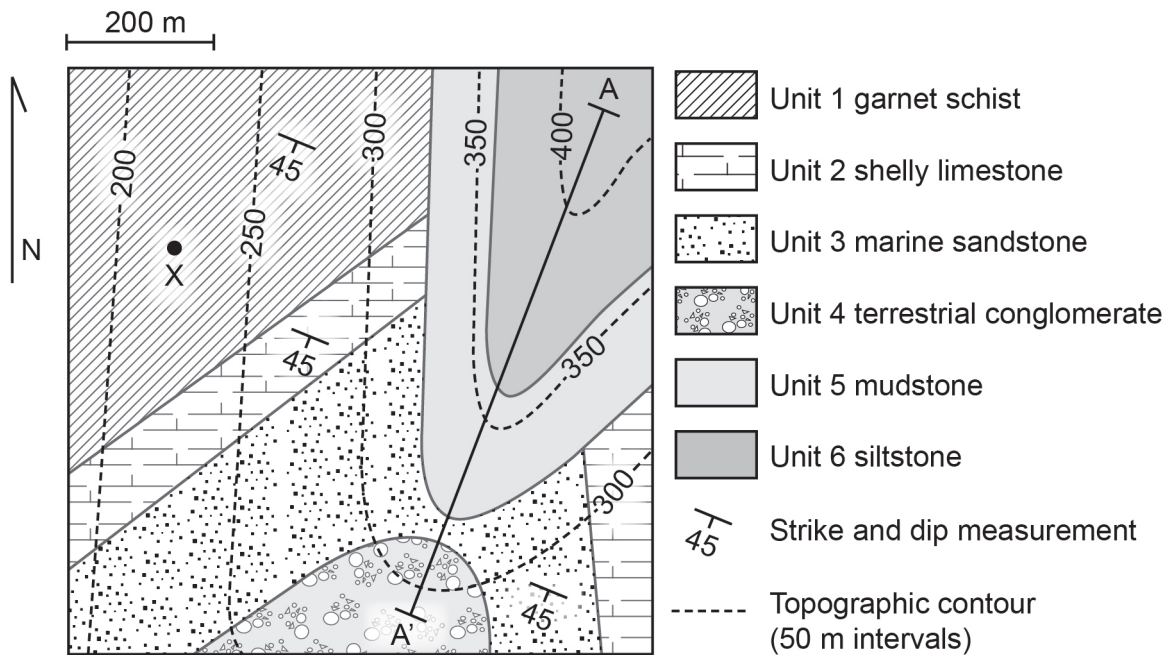
(4 marks)

- (c) Suggest **two** methods that are (or feasibly could be) applied to prevent or reduce the level of eutrophication occurring in affected waterways. (4 marks)

Question 21

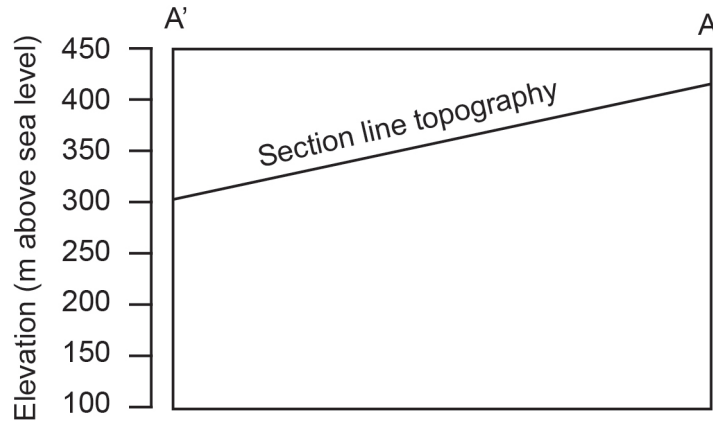
(11 marks)

The map below displays the known geology for an area you are investigating. Use this to answer the following questions.



- (a) During fieldwork to test the accuracy of the map, you find a previously-unrecorded basalt dyke cropping out at Point X. Further investigation shows that the dyke is approximately 50 m wide, strikes E-W, intrudes vertically into the country rock and is older than the mudstone unit, but younger than the limestone. Add the dyke as a feature to the map provided, showing its predicted distribution at the surface. (2 marks)
- (b) The metamorphism of the schist unit in the north-west of the mapped area would require temperatures and pressures corresponding to many kilometres of burial below the surface, but the overlying unit is an un-metamorphosed marine limestone, deposited in a shallow sea. Outline the geological history required to explain the current relationship of these two units. (2 marks)

- (c) Produce 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 to a depth of 200 m below the lowest point of topography shown, including the dyke added in part (a). Note: to assist you in transcribing strata locations, you may remove page 41 by tearing along the perforations. (6 marks)



- (d) What does the changing lithological character of Units 2, 3 and 4 (shelly limestone, marine sandstone and terrestrial conglomerate) indicate about the variation in local conditions over time during their formation? (1 mark)

Question 22

(11 marks)

The photograph below shows an outcrop of a metamorphic rock with closely-spaced parallel laminations of light and dark minerals. The rock breaks easily along these laminations, and crystals of a dark, highly-reflective platy mineral are visible to the naked eye aligned along these preferential fracture surfaces.



- (a) Complete the table below to provide valid names for the features indicated. (3 marks)

Feature	Name
the rock type shown and described above	
the prominent dark, platy mineral present	
the texture created by alignment of the platy minerals in this rock	

- (b) List **three** minerals that usually form in the type of rock described above, but do **not** form in sedimentary environments. (3 marks)

- (c) Describe **two** changes this rock might display if it had experienced higher pressures and temperatures. (2 marks)

- (d) A substantial amount of water is usually released during regional metamorphism. Explain how such water can contribute to the formation of economic mineral deposits. (3 marks)

Question 23

(12 marks)

To be classified as renewable, a resource must be able to be replenished by natural processes as fast or faster than it is being harvested, so that extraction can continue indefinitely.

- (a) Identify **three** potentially-renewable resources exploited commercially in Western Australia. (3 marks)

- (b) The sustainability threshold of a resource represents the level of extraction that is possible without affecting the continued replenishment of that resource. For **one** of the resources identified above, discuss how the sustainability threshold of the resource is (or reasonably could be) determined. (3 marks)

- (c) Describe the likely consequences to this resource if extraction exceeded its sustainability threshold. (3 marks)

- (d) Discuss how a natural or human-induced process other than commercial extraction might reduce the sustainability of this resource. (3 marks)

Question 24

(11 marks)

The availability and viability of geothermal energy resources is controlled by the distribution of heat within the Earth's crust.

- (a) Discuss **two** factors that influence the distribution of heat within the upper 5 km of the Earth's crust. (6 marks)

- (b) Identify **two** factors that would be important to consider when evaluating the potential of a region to produce geothermal power. (2 marks)

- (c) Describe a method of exploration or evaluation that would be suitable for investigating **one** of these factors, and explain how it would be applied to assess the geothermal potential of the region. (3 marks)

Question 25

(11 marks)

In December 2015, leaders of 195 countries met at the United Nations Climate Change Conference. The scientific view accepted was that the volume of human-produced greenhouse gases, including methane and carbon dioxide, had increased greatly in the last century, and that this had already contributed to climate change.

- (a) Identify and explain an example of how increased food production has contributed to increased levels of methane in the atmosphere. (2 marks)

- (b) Explain how increases in atmospheric carbon dioxide, methane and other greenhouse gases contribute to climate change. (3 marks)

- (c) Rising global temperatures are thought to be already causing changes in the nature and operation of the hydrosphere. Identify and explain a way in which **one** part of the hydrosphere is changing. (3 marks)

- (d) Identify and describe **one** change in energy use that Australia might adopt to reduce the amount of carbon dioxide released to the atmosphere every year, while continuing to meet its energy needs. (3 marks)

End of Section Two

See next page

Section Three: Extended response

30% (30 Marks)

This section contains **three (3)** questions. You must answer **two (2)** questions: the compulsory question (Question 26) and **one (1)** of the other questions (Question 27 **or** Question 28). Write your answers on the pages provided following Question 28.

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

Suggested working time: 60 minutes.

Question 26 (compulsory)

(15 marks)

Australia is the driest populated continent on Earth, yet Australians are among the highest per capita water consumers in the world. This places substantial stress on many freshwater resources around the nation. In the 1970s, water stored in dams and reservoirs in the hills above Perth supplied 90% of the city's freshwater needs. Over the past 40 years that figure has fallen to around 20%, with further decreases projected into the future.

Discuss the causes and implications of this substantial change in water supply for the Perth region. In your answer, you should:

- (a) Discuss the social and hydrological factors in Western Australia which, over the past 40 years, have decreased the ability of surface water sources to meet the needs of Perth. (5 marks)

- (b) Identify **two** strategies or policies regarding water use that people in Western Australia have adopted, or could adopt, to reduce their freshwater needs, and describe a social or industrial implication of each. (4 marks)

- (c) Surface water (such as rivers, lakes and reservoirs) cannot provide for the projected freshwater needs of Western Australia over the next 20 years. Evaluate the potential of other sources to reduce or solve this problem. (6 marks)

Question 27**(15 marks)**

Discuss the potential impact of earthquakes on society and suggest measures that might reduce this impact. In your answer, you should:

- (a) Outline how scientists identify regions at risk from earthquake hazard. (5 marks)

- (b) Describe **two** short-term impacts and **one** longer-term consequence on human population or infrastructure that would result from a large earthquake occurring in a heavily-populated area such as a city. (6 marks)

- (c) Suggest **two** measures that have been (or could reasonably be) taken in earthquake-prone regions to reduce the impact on humans of major earthquakes. (4 marks)

or

Question 28**(15 marks)**

Discuss the formation of volcanoes, the potential hazard they pose, and the impact they have on the Earth's weather and climate. In your answer, you should:

- (a) Choose a plate tectonic environment and outline, with the aid of a diagram, how the processes occurring there can lead to the formation of volcanoes and volcanic eruptions. (7 marks)

- (b) Describe how magma composition can affect the character of eruption and therefore the hazard potential of a volcano. (4 marks)

- (c) Describe **two** ways by which the emissions from a large volcanic eruption might influence the weather or climate of a region. (4 marks)

End of questions

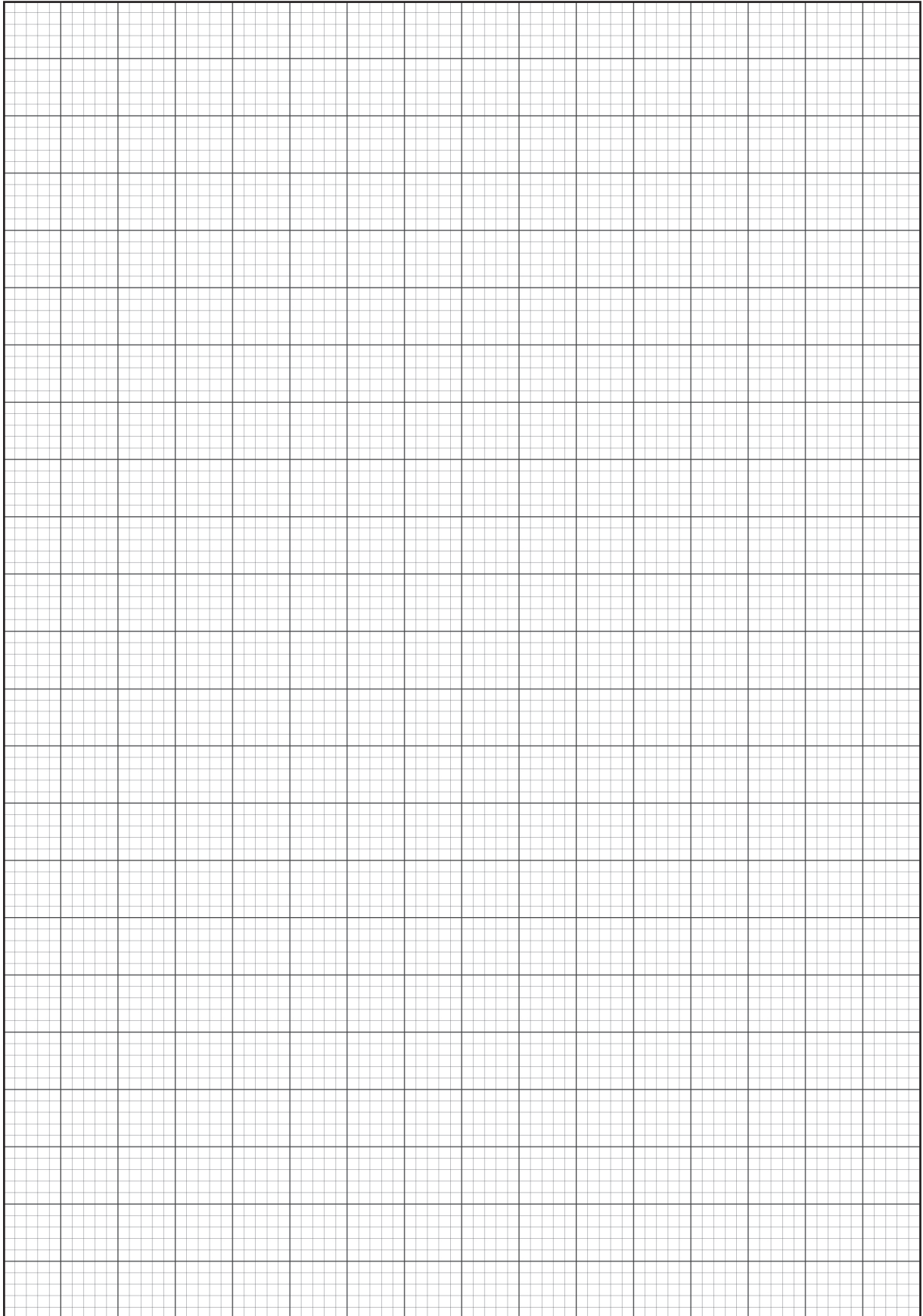
You may tear along the perforations to use this page (to transcribe strata locations for Question 21).

This page is to be used for transcribing strata locations only

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This page is to be used for transcribing strata locations only

Question 19



ACKNOWLEDGEMENTS

Question 22

Photograph by courtesy member of examining panel.

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