Government of **Western Australia**
School Curriculum and Standards Authority

ATAR course examination, 2022

Question/Answer booklet

EARTH AND ENVIRONMENTAL SCIENCE

Please place your student identification label in this box

WA student number: In figures

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, up to three calculators, which do not have the capacity to create or store programmes or text, are permitted in this ATAR course 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	8	8	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 external examinations are detailed in the *Year 12 Information Handbook 2022: Part II Examinations*. 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 preferably using a blue/black pen. Do not use erasable or gel pens.

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.

See next page

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. Which of the following would be the **most** appropriate advice for when to calculate and record your location during field research?

   (a) whenever your phone has no signal
   (b) whenever recording observations or collecting a sample
   (c) when taking a photograph
   (d) at the start and end of each day of fieldwork

2. Healthy ecosystems provide a range of renewable resources through their function, including carbon sequestration and climate control. These resources are examples of

   (a) supporting services.
   (b) provisioning services.
   (c) managing services.
   (d) regulating services.

3. El Niño weather conditions are caused by

   (a) warmer than average surface water in the central and eastern tropical Pacific Ocean.
   (b) strengthening of the equatorial trade winds.
   (c) cooling of deep water currents in the western Pacific Ocean.
   (d) air pressures higher than average in the eastern Pacific and lower than average in the western Pacific.

4. Climate change models predict that global warming could result in some areas of Northern Europe experiencing dramatic cooling. This cooling would be caused by

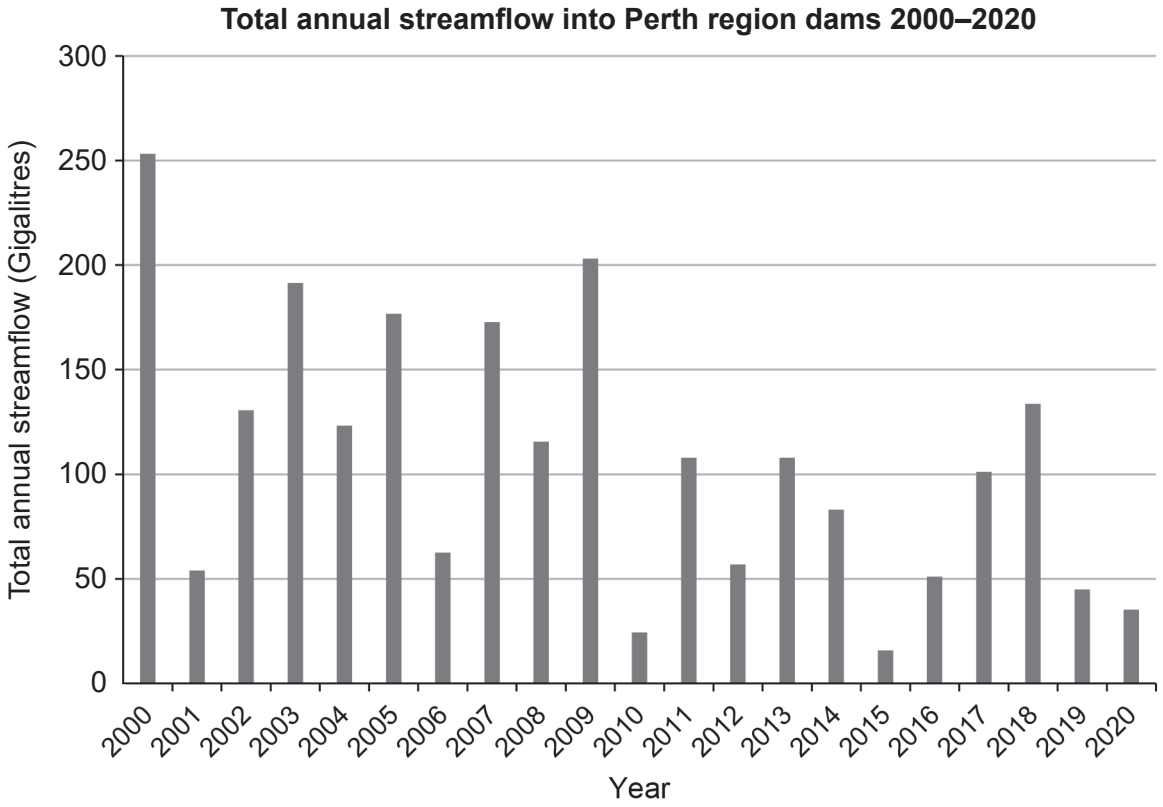
   (a) spread of glaciers from Greenland.
   (b) cessation of the Gulf Stream.
   (c) reversal of the Trade Winds.
   (d) greater evaporation in Northern Europe.

See next page

5. The underwater eruption of the volcanic island of Hunga Tonga on 15 January 2022 caused a significant tsunami throughout the southwest Pacific Ocean region. The sequence of events that caused this tsunami was **most** likely

(a) lava flows melting glaciers on the volcano, leading to rapid release of sediment-laden water into the ocean.
(b) an explosive eruption, causing the collapse of the volcano rim and releasing a large crater lake.
(c) an explosive underwater eruption, causing a sudden displacement of a large volume of sea water.
(d) a large subduction zone earthquake, causing a rapid uplift of the sea floor, displacing the overlying water.

6. The graph below shows the total annual volume of streamflow into Perth region dams between 2000 and 2020.



On the basis of the information provided in the graph, which of the following statements is **not** true?

(a) The five years with the lowest recorded streamflow all occurred after 2009.
(b) The mean annual streamflow between 2000 and 2009 was greater than the mean annual streamflow between 2010 and 2019.
(c) The greatest single-year drop in streamflow recorded was between 2000 and 2001.
(d) The annual streamflow did not rise for more than two consecutive years over the period recorded.

See next page

Refer to the table below which shows the El Niño-Southern Oscillation (ENSO) classification of the years 2000 to 2020 to complete Question 7.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
El Niño			X		X		X								X	X				X	
Neutral		X		X		X				X			X	X			X		X		
La Niña	X							X	X		X	X						X			X

7. Combined with the streamflow data shown in Question 6, which of the statements below is true?

   (a) The three years with the highest recorded Perth streamflow were all La Niña years.
   (b) The three years with the lowest recorded Perth streamflow were all El Niño years.
   (c) Every El Niño year between 2005 and 2020 was associated with a fall in recorded Perth streamflow.
   (d) Every La Niña year between 2000 and 2015 was associated with a rise in recorded Perth streamflow.

8. Why are mica crystals visible to the naked eye in schist, but not in phyllite?

   (a) Schist contains mica, but phyllite does not.
   (b) Phyllite is a contact metamorphic rock, whereas schist is formed by regional metamorphism.
   (c) The mica in phyllite is too small to see without magnification.
   (d) Phyllite is a metamorphic rock composed entirely of amphibole.

9. Which of the following is **not** an environmental consideration for the decommissioning of a resource site?

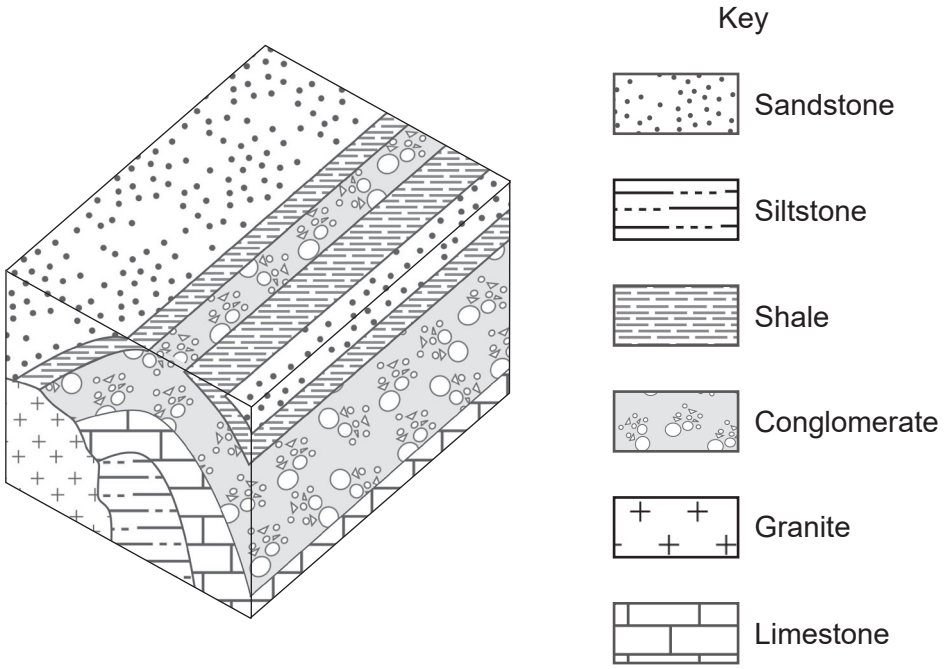
   (a) contamination of nearby water supplies
   (b) drillholes left open after mining
   (c) post-mining land use
   (d) the location of waste stockpiles

10. A junior researcher is investigating the impact of exploration camps on feral cat populations in remote Western Australian. Which of the following sources could provide secondary data relevant to her study?

    (a) reports by the Department of Environment counting feral cat populations
    (b) reports by a private company on the impact of feral cats on native animals
    (c) results of an historic investigation on local wildlife and exploration programs
    (d) all of the above

See next page

Refer to the block diagram shown below to complete Question 11.



11. On the basis of the relationships shown in the block diagram, which of the following statements is correct?

(a) The shale was deposited after a folding event.
(b) The youngest rock unit shown in the diagram is not exposed at the surface.
(c) The shale contains abundant fossil layers.
(d) Granite is the oldest unit.

12. In which of the Earth's layers are all economically viable mineral resources located?

(a) crust
(b) asthenosphere
(c) mesosphere
(d) outer core

13. Ocean surface currents are controlled primarily by

(a) ocean-water salinity.
(b) prevailing winds.
(c) seismic activity.
(d) air pressure.

See next page

14. Ultramafic lava flows are **most** commonly associated with which type of resource deposit?

(a) gold
(b) iron ore
(c) nickel
(d) copper

15. The lack of oxygen in the Earth's early atmosphere was important to the formation of Banded Iron Formations (BIF) because

(a) reduced iron could accumulate in the Earth's oceans.
(b) oxygen could accumulate in the Earth's oceans.
(c) iron oxide could accumulate in the Earth's oceans.
(d) oxygen prevents the precipitation of BIF.

End of Section One

See next page

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

This section has **eight** 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 **(13 marks)**

Flood plains are areas of low-lying land located next to streams or rivers. During early European settlement, many Australian flood plains were drained so that the areas could be used for farming. Later, urban development has seen many flood plain regions developed for housing and commercial use.

(a) State **two** reasons why flood plain regions are used for urban development. (2 marks)

One: _____

_____

Two: _____

_____

(b) Explain how occasional floods on flood plains improve their suitability for agriculture. (3 marks)

_____

_____

_____

_____

_____

_____

(c) Describe **two** social or environmental benefits for communities that choose **not** to allow development on local flood plain areas. (4 marks)

One: _____

Two: _____

(d) Describe how **two** human activities can prevent the natural rejuvenation of flood plain environments. (4 marks)

One: _____

Two: _____

See next page

Question 17 **(14 marks)**

Geophysical exploration programs use distinctive variations in geophysical response between economic minerals and surrounding rocks in order to identify areas that may host ore bodies.

(a) While preparing an area for grazing, a farmer in a remote area of Western Australia exposed a horizon of potentially valuable sulfide minerals under a thick layer of silica-cemented sediments. Explain how an electromagnetic survey could be used to define the location and extent of the sulfide mineralisation. (3 marks)

(b) Other than electromagnetic surveys, describe a different geophysical exploration method that could be used for identifying prospective areas for each of the following:

(i) mineral resource. (2 marks)

(ii) non-renewable energy resource. (2 marks)

(c) Explain why exploration companies commonly use additional non-geophysical methods to confirm the presence of mineralisation identified by geophysical surveying. (3 marks)

(d) Describe **two** non-geophysical exploration techniques that can be used to identify the presence of or the location, and extent of mineralisation beneath the surface. (4 marks)

One:

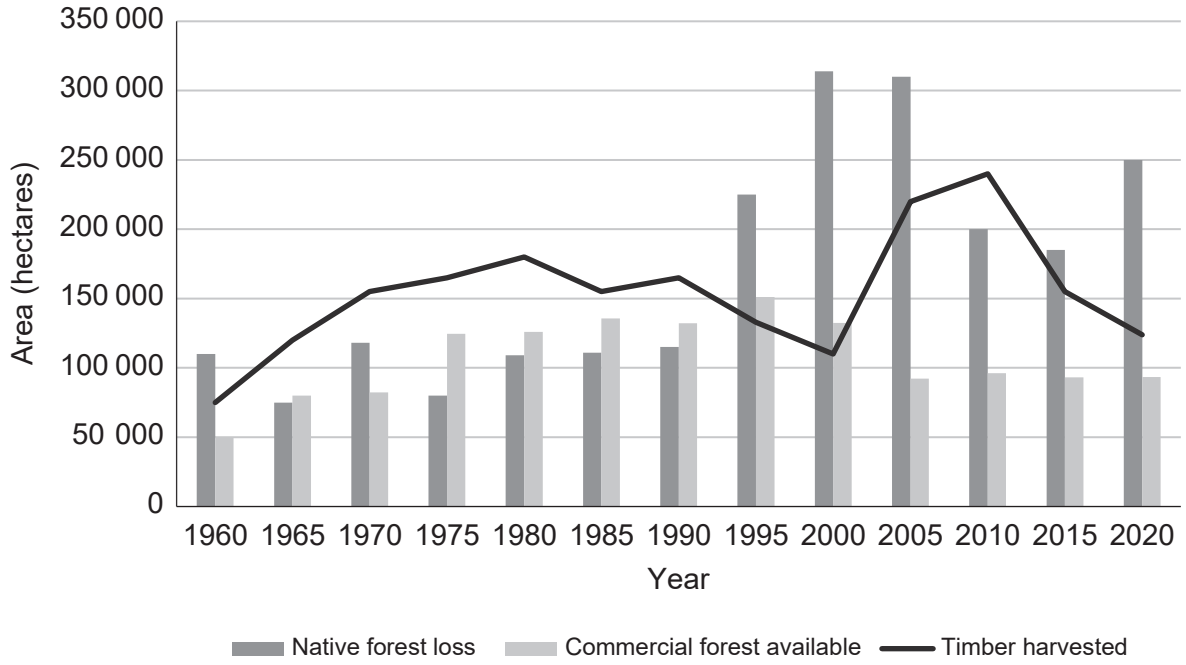
Two:

Question 18 **(16 marks)**

Timber is considered an ecosystem service that allows for the provision of goods needed by society. For a forest ecosystem to remain healthy while providing this service, the timber must be harvested at sustainable rates and the forest must be regenerated effectively.

Consider the following graph.

Forestry and timber data from a woodland 1960–2020



(a) State **one** human-related and **one** natural cause that could be responsible for the higher rates of native forest loss experienced after 1995. (2 marks)

Human-related: _____

_____

Natural: _____

_____

(b) Identify **two** other trends, apart from those stated above, that are apparent in the data shown. (2 marks)

One: _____

_____

Two: _____

_____

See next page

(c) Describe **two** factors that can have an impact on the rate of renewal of a harvestable resource. (4 marks)

One: _____

Two: _____

(d) Outline the importance of maintaining a sustainable ecosystem. (2 marks)

(e) Describe **three** initiatives that a government could introduce in the timber and forestry industry to help regulate native forest loss. (6 marks)

One: _____

Two: _____

Three: _____

See next page

Question 19 **(12 marks)**

Metamorphic rocks are rocks whose original mineralogy and/or texture have been changed by the effects of heat and pressure.

(a) Describe the processes of regional metamorphism **and** contact metamorphism. (4 marks)

Regional metamorphism: _____

_____

_____

_____

Contact metamorphism: _____

_____

_____

_____

(b) Complete the table below to create a classification key to distinguish between amphibolite, schist, and phyllite rock types. (6 marks)

Metamorphic rock type	Distinctive mineralogy	Textural features
Amphibolite		
Schist		
Phyllite		

(c) Explain why some metamorphic rocks consist of only a single mineral and others consist of multiple minerals. (2 marks)

_____

_____

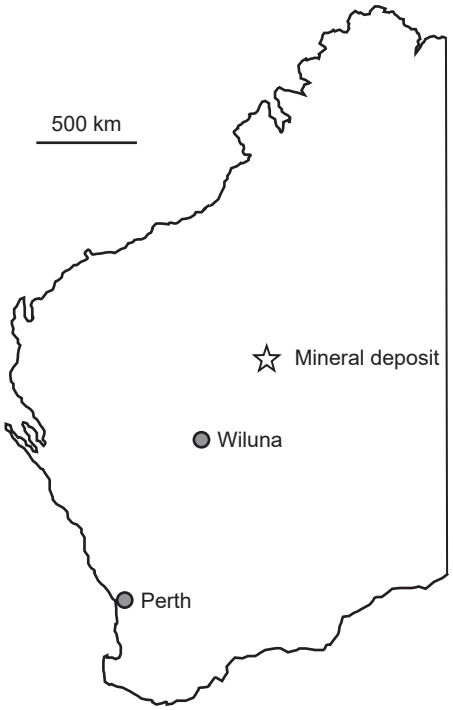
_____

_____

See next page

Question 20 **(16 marks)**

Once a new mineral deposit is identified, economic viability is a key consideration in whether or not a mine will be developed to extract the mineral resource. An exploration company has discovered several small but potentially valuable gold deposits at the site marked with a star on the map below. The site is approximately 500 km NE of the nearest small rural town of Wiluna, and 1300 km NE of Perth.



(a) Identify **two** geographic and **two** social factors that could affect the economic viability of these deposits. (4 marks)

Geographic

One: _____

Two: _____

Social

One: _____

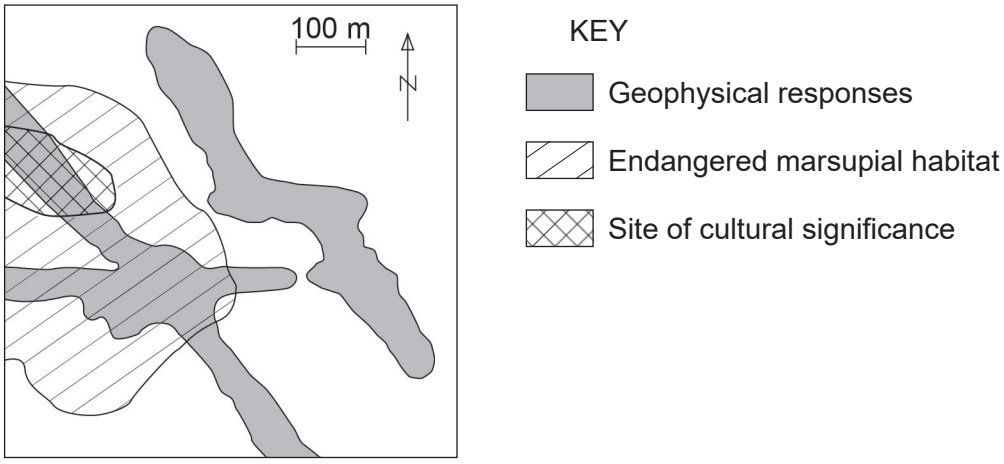
Two: _____

Question 20 (continued)

(b) The characteristics of two separate deposits from this site are identified below. Complete the table by identifying the method of extraction most suited to each deposit. (2 marks)

Deposit characteristics	Most suitable method of extraction
Evenly and widely distributed low-grade ore from a depth of 20 m below the surface	
High-grade ore concentrated in a narrow band of veins located 150 m below the surface	

The map below shows that geophysical responses indicate the likely presence of valuable mineralisation extending across parts of the habitat of an endangered marsupial, and across an area identified as having significant cultural importance to local native title holders.



(c) (i) Describe **two** ways in which a potential mine developer could respond to the presence of the endangered marsupial, and the likely impact of these measures on the economic viability of mine development. (4 marks)

One: _____

_____

_____

_____

Two: _____

_____

_____

_____

(ii) Describe **two** implications that the identified area of cultural importance could have for mine approval. (4 marks)

One: _____

_____

_____

_____

Two: _____

_____

_____

_____

(d) If the mineral deposit was to be developed, a local site would need to be identified for the permanent disposal of waste rock and mine tailings.

(i) On the map on page 16, mark an X to identify a suitable location for such disposal. (1 mark)

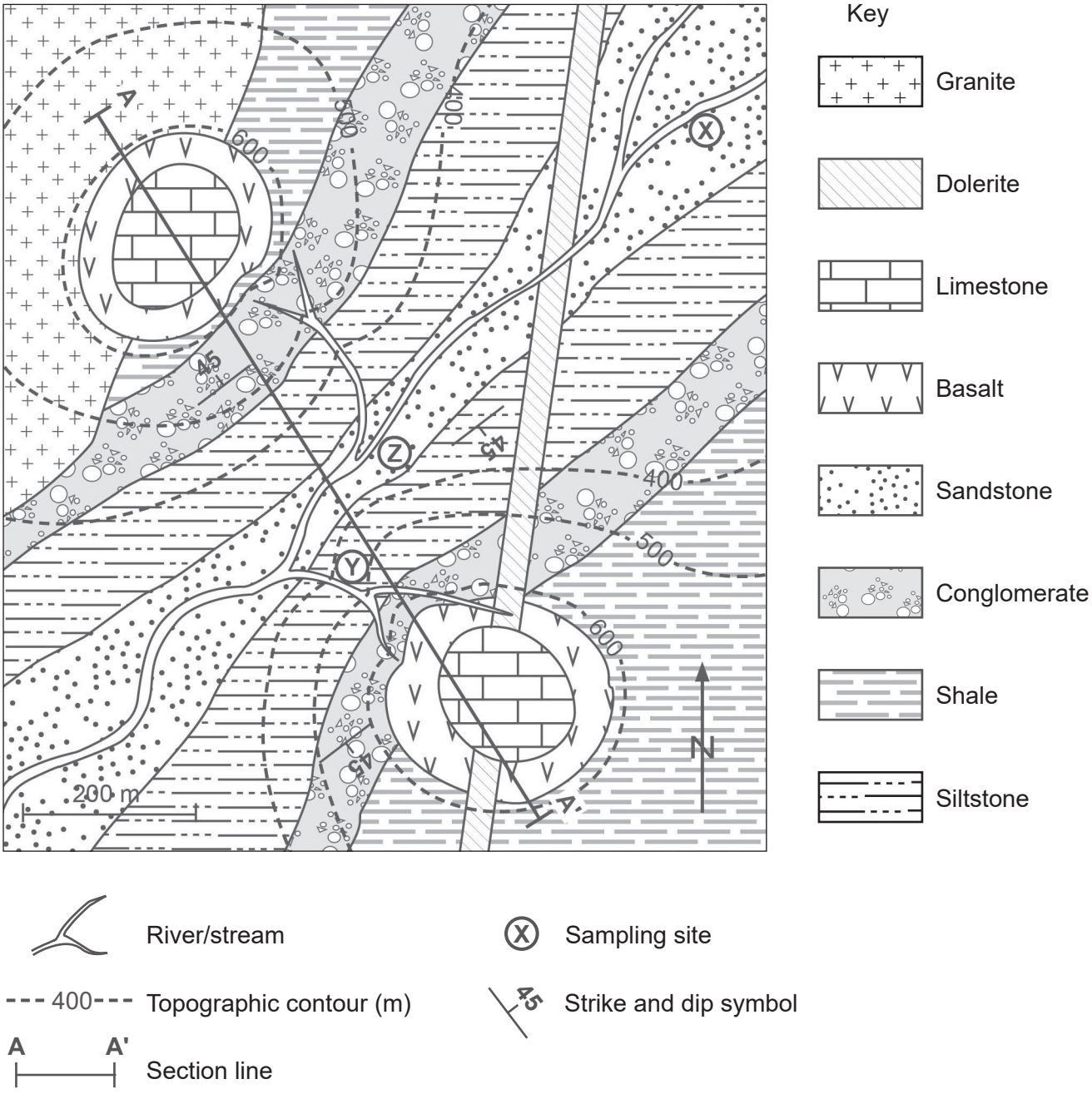
(ii) State a reason justifying your decision to locate the waste facility at your chosen location. (1 mark)

_____

_____

Question 21 **(14 marks)**

The map below represents the known distribution of rocks across a region being investigated by geologists.



(a) Identify the oldest lithology in the mapped area. (1 mark)

_____

See next page

(b) Produce a cross-section along the line A–A' on the section provided below showing interpreted geology projected to sea level (0 m elevation). Note: to assist you in transcribing strata locations you may remove page 41 by tearing along the perforations. (6 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 and indicate that you have redrawn it on the spare section line.

(c) The granite, dolerite and basalt all reflect different styles of igneous activity. On the basis of the relationships shown in the map, state how the basalt may have been emplaced in this area, and name **one** piece of evidence you would look for in the field to test your suggestion. (2 marks)

(d) An area of metamorphic change is present in rocks adjacent to the granite. Identify **two** textural or mineralogical differences you might expect to see in this metamorphosed rock compared to its protolith in the area. (2 marks)

One:

Two:

Question 21 (continued)

(e) On the map on page 18, draw in the direction of water flow of the stream. (1 mark)

(f) Some historical stream sampling data is available from the sampling site points marked as X, Y and Z on the map on page 18. Results from these points are shown below.

Stream sample analysis			
Metal	**Sample content (weight %)**		
	X	**Y**	**Z**
Copper (Cu)	<0.001	<0.001	<0.001
Lead (Pb)	<0.001	<0.001	<0.001
Gold (Au)	<0.001	0.48	0.46
Silver (Ag)	<0.001	0.09	0.10

(i) Identify a possible source rock for the high levels of gold observed in some of the samples analysed. (1 mark)

(ii) State a reason justifying the source rock chosen. (1 mark)

See next page

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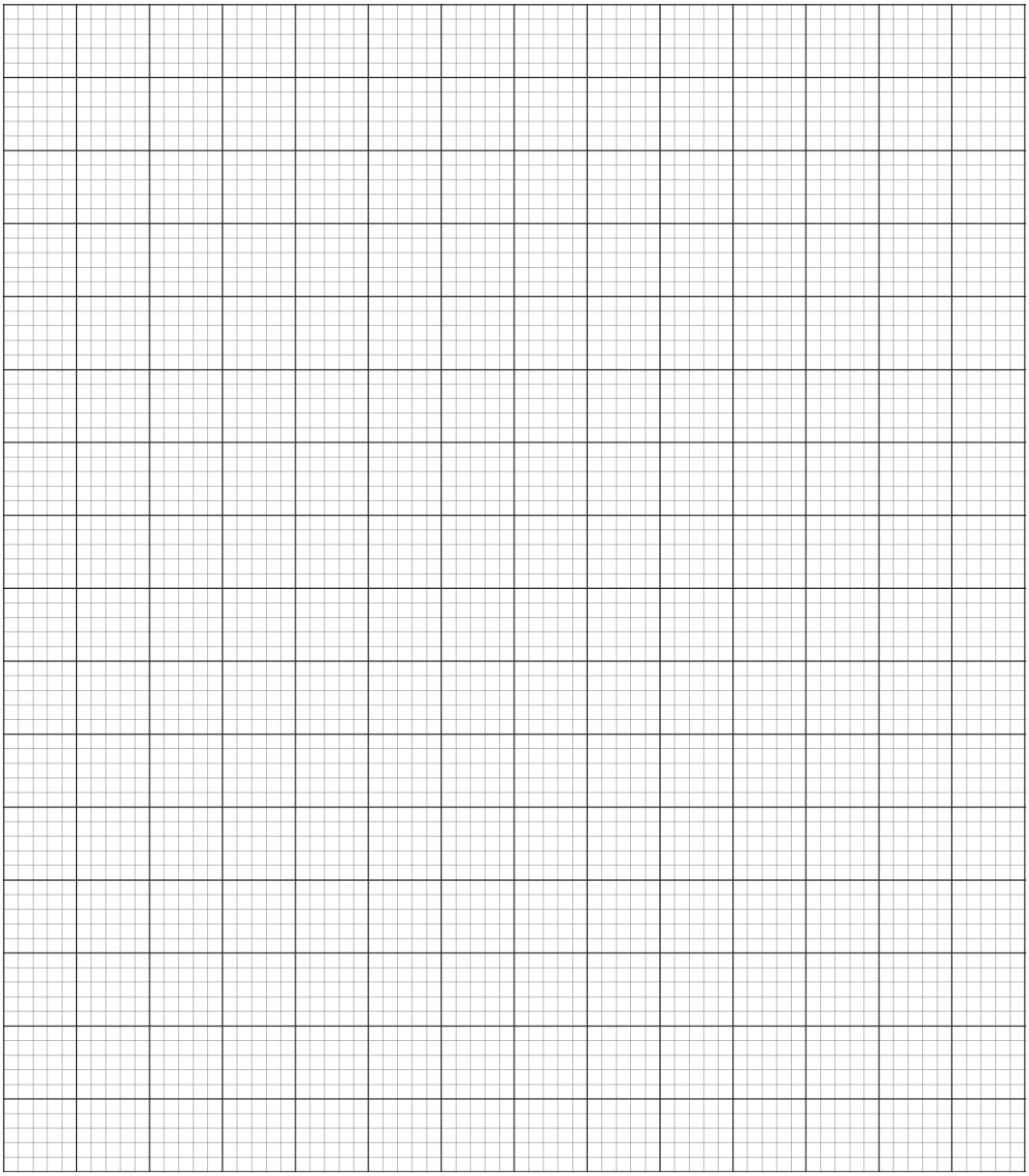
See next page

Question 22 **(11 marks)**

The koala has been classified as a vulnerable species by the Australian Government since 2012. The results of research begun in 2008, tracking the estimated national koala population, are shown in the table below.

Year	2008	2010	2013	2014	2015	2016	2018	2019	2020
Estimated koala population ('000)	145	144	139	139	133	128	120	115	58

(a) Using the grid provided below, draw a line graph of the data shown in the table. (5 marks)



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

See next page

(b) State a long-term trend identified in the data. (1 mark)

(c) The dramatic change reported in the estimated koala population between 2019 and 2020 was initially dismissed by foreign biologists as an error. Using Australian environmental factors, describe how this fall in numbers could be caused. (2 marks)

(d) Assuming that the 2019 and 2020 figures are accurate, outline an implication of this dramatic decrease in population for the vulnerability of koalas in the wild. (1 mark)

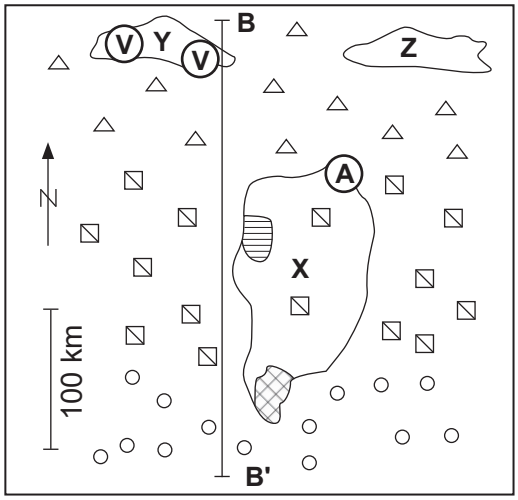
(e) Identify **two** methods of protecting koalas in the wild that could be used to decrease their vulnerability. (2 marks)

One:

Two:

Question 23 **(14 marks)**

The map below shows a group of islands (X, Y, and Z) and the distribution of earthquakes and volcanic activity around an active tectonic plate boundary. The boundary itself is not shown.



KEY

- Major city
- Military base
- (A) Proposed location
- Shallow earthquake (0–30 km)
- Intermediate earthquake (30–200 km)
- Deep earthquake (>200 km)
- (V) Active volcano
- Section line B B'

(a) Draw a labelled sketch cross-section along the line B–B' showing the nature of the tectonic plate boundary. Show the approximate location and orientation of your section line on the map. Your section should also include any additional geological or structural features you would expect to be present. (5 marks)

(b) To reduce the vulnerability of the military base on Island X to natural hazards, the Government has decided to move it from its current location to the site labelled 'A' in the north of the island. State the primary hazard the base would be exposed to at its current location, and describe how moving the base to site 'A' would reduce risk from this hazard. (3 marks)

(c) Island Y in the north of the region shown hosts two active volcanoes. Describe **two** different types of volcanic hazard you would expect this island to experience. (4 marks)

One:

Two:

(d) Explain why the hazards listed above would differ from those experienced on an active island volcano far in the interior of a tectonic plate and removed from the influence of plate boundaries. (2 marks)

End of Section Two

See next page

Section Three: Extended answer **30% (30 Marks)**

This section contains **three** questions. You must answer **two** questions: the compulsory question (Question 24) and **one** of the other questions (Question 25 **or** Question 26). Write your answers on the pages provided following Question 26.

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

Suggested working time: 60 minutes.

Question 24 **(15 marks)**

Global climate has changed over geological time.

(a) Explain how **two** types of evidence can demonstrate climate change outside human history. (6 marks)

(b) Describe how **two** natural processes have contributed to global climate change over geological timescales. (4 marks)

(c) Choose **one** of the following: the atmosphere, geosphere or hydrosphere, and outline how climate change has made an impact upon it. (2 marks)

(d) Using a relevant example, explain how climate change over time affects the distribution of plant or animal species. (3 marks)

See next page

Question 25 **(15 marks)**

For any one non-renewable mineral or non-renewable energy resource address the following question parts.

(a) With the aid of a labelled diagram, explain how geological processes can lead to the formation of your chosen resource, using a specific example or examples drawn from real resource systems where appropriate. (7 marks)

(b) On the basis of your answer to part (a), explain how their tectonic setting can influence the location of the kind of non-renewable resource described. (4 marks)

(c) Describe **one** example of how extraction of your chosen resource can affect the abiotic components of the surrounding ecosystem, and **one** example of how its extraction can affect the biotic components of the surrounding ecosystem. (4 marks)

or

Question 26 **(15 marks)**

Artificial oxygenation has been used since 2008 to increase low oxygen levels in the Swan River in Perth.

(a) Explain how a human activity can deplete the oxygen levels in a river. (4 marks)

(b) Explain a possible outcome for river ecosystems if oxygen levels depleted by human activity are not increased by artificial oxygenation or other management practices. (3 marks)

A hypothetical proposal has been made to develop a hydroelectric power station in the upper reaches of a major Western Australian river.

(c) Describe **two** factors (atmospheric, hydrologic or social) that should be taken into consideration in evaluating such a proposal. (4 marks)

Demand for fresh water is expected to rise in Perth over the coming decades, and no additional surface water sources are available to meet this anticipated need.

(d) Describe **two** alternative methods for increasing the availability of drinking-quality water. (4 marks)

End of questions

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Supplementary page

Question number: _____

Supplementary page

Question number: _____

Spare section line for Question 21(b)

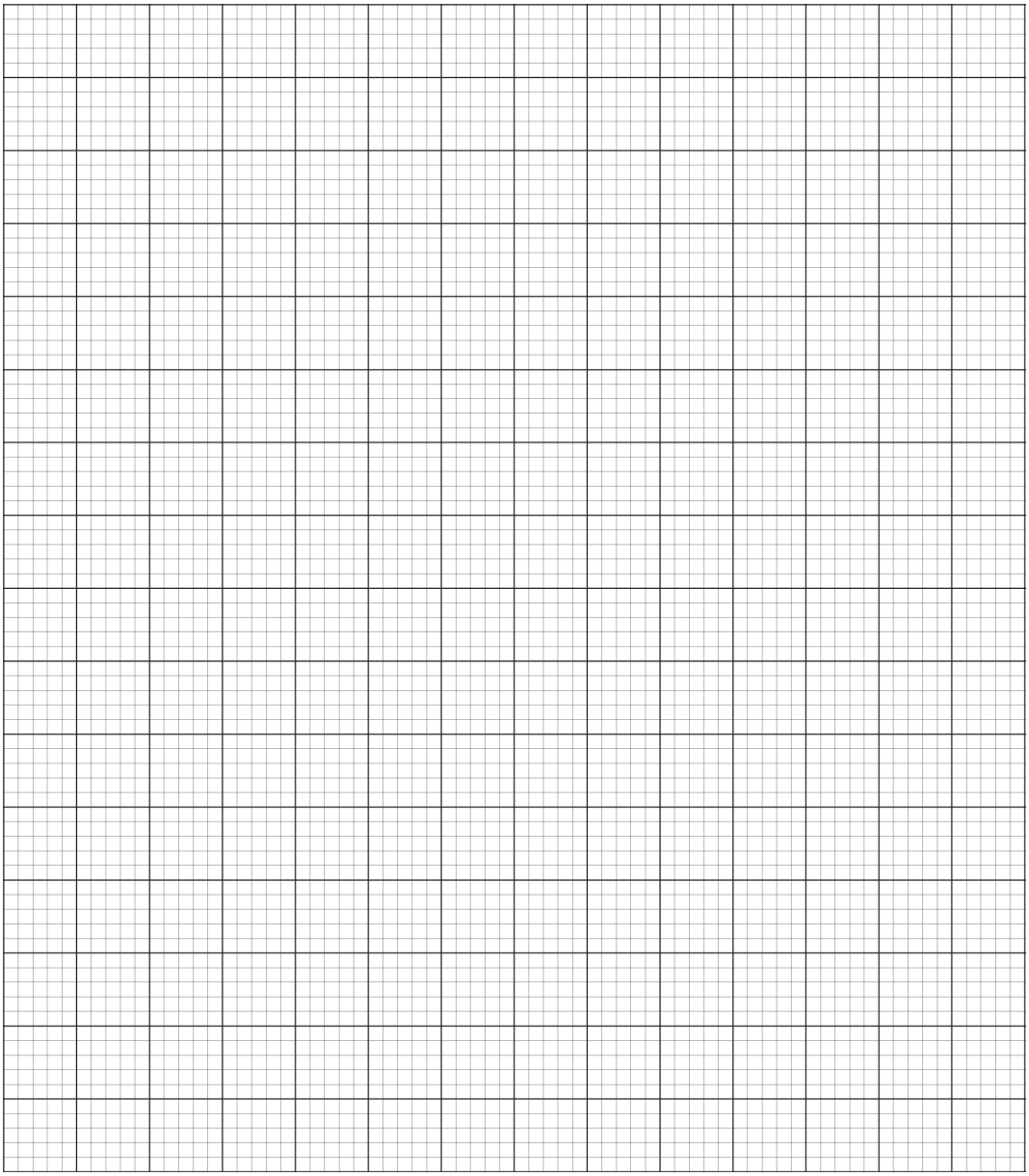
You may tear along the perforations to use this page (to transcribe strata locations for Question 21).

This page is to be used for transcribing strata locations only

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

Spare grid for Question 22(a)



ACKNOWLEDGEMENTS

Question 6 Data from: Water Corporation. (2022). *Historical annual streamflow* [Graph]. Retrieved March, 2022, from https://www.watercorporation.com.au/Our-water/Rainfall-and-dams/Streamflow

Question 7 Data from: Bureau of Meteorology. (2022). *ENSO outlook values* [Table]. Retrieved March, 2022, from http://www.bom.gov.au/climate/enso/outlook/#tabs=ENSO-Outlook-history

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