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

WACE
Western Australian Certificate of Education

Western Australian Certificate of Education Examination, 2014

Question/Answer Booklet

EARTH AND ENVIRONMENTAL SCIENCE

Stage 3

Please place your student identification label in this box

Student Number: In figures | | | | | | | | |

In words _____

_____

Time allowed for this paper

Reading time before commencing work: ten minutes
Working time for paper: 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 the WACE examinations

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 notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

 Ref: 14-037

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Multiple-choice	15	15	20	15	15
Section Two: Short answer	10	10	100	110	55
Section Three: Extended response	3	2	60	30	30
				Total	100

Instructions to candidates

1. The rules for the conduct of Western Australian external examinations are detailed in the *Year 12 Information Handbook 2014*. 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 responses to the specific questions asked and to follow any instructions that are specific to a particular question.

4. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.
   - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
   - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question that you are continuing to answer at the top of the page.

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. 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. Identify the rock that most closely fits the following description: a coarse grained igneous rock consisting of approximately 65% feldspar, 5% quartz and 30% dark minerals.

   (a) granite
   (b) diorite
   (c) gabbro
   (d) andesite

2. Which of the following is an outgoing source of energy for Earth's global energy budget?

   (a) radioactive decay occurring in the Earth's interior
   (b) tidal energy resulting from the Sun's and the Moon's gravity
   (c) solar radiation produced by the Sun
   (d) energy reflected from the upper surface of clouds

3. The effects of which of the following climatic features are likely to be reduced because of proximity to a large body of water, such as an ocean?

   (a) average summer temperatures
   (b) average winter temperatures
   (c) humidity and rainfall
   (d) sea breeze intensity

4. Which of the following is **not** a feature of volcanism associated with mantle hot spots?

   (a) large volcanoes with low angled slopes
   (b) high temperature magma of low viscosity
   (c) intermediate magma with high gas content
   (d) volcanoes composed mainly of lava layers

See next page

5. Ozone is continuously being created in the atmosphere. This process is **mainly** due to

(a) high atmospheric concentrations of chlorofluorocarbons (CFCs).
(b) ultraviolet (UV) radiation produced by the Sun.
(c) pollution produced from the burning of fossil fuels.
(d) increasing levels of carbon dioxide in the atmosphere.

6. Which of the following would be a probable consequence of a sea level rise of one metre over the next 100 years?

(a) decreased volcanism in Indonesia
(b) increased production of ozone in the troposphere
(c) retreat of glaciers in the Andes
(d) vertical growth of coral reefs in Fiji

7. Jane found a pale grey and fine-grained rock exposed in the field. Using a hand held magnifying lens, she recognised crystals of plagioclase feldspar, pyroxene, and rare examples of quartz, all growing in a randomly aligned interlocking texture. What is the most reasonable interpretation of the specimen's rock type?

(a) quartzo-feldspathic gneiss
(b) pyroxene-bearing limestone
(c) andesite
(d) quartz diorite

8. Which of the following human activities has had the **greatest** impact on the biomass on the Earth?

(a) the destruction of plants by acid rain produced by releasing sulfur dioxide and nitrous oxides into the atmosphere
(b) the burning of plants as fuel for heating and cooking
(c) the clearing of forests, woodlands and grass plains to provide space in greatly-expanded towns and cities for housing, industry and transport
(d) the clearing of forests and woodlands to provide space for agriculture

9. Compared with nearby locations at a lower elevation, the **main** effect of elevation on climate in Australia is that, at higher elevations,

(a) temperatures in both summer and winter are lower.
(b) the annual rainfall total is higher.
(c) the variation between daytime and night-time temperatures is greater.
(d) the wind always blows at greater speed.

See next page

10. Which of the following lists shows only processes that release carbon into the atmosphere?

(a) respiration, combustion, decomposition
(b) photosynthesis, respiration, decomposition
(c) decomposition, diffusion, combustion
(d) combustion, respiration, diffusion

11. Reduced solar energy received by areas of higher latitude is due mainly to

(a) an increased distance of these areas from the Sun.
(b) the effect of the Earth's tilted axis on atmospheric thickness.
(c) the spread of incoming solar radiation over a larger area.
(d) the reduced ozone concentrations in these areas.

12. Which of the following would contribute **least** to the motion of ocean currents?

(a) the Coriolis effect
(b) salinity differences
(c) shoreline configuration
(d) orographic lift

13. Which of the following acids is a major contributor to the properties of acid rain?

(a) hydrochloric
(b) nitric
(c) carbonic
(d) ethanoic

14. Which of the following of the Earth's carbon reservoirs contains the largest mass of carbon?

(a) atmosphere
(b) fossil fuels
(c) oceans
(d) land vegetation

15. Which of the following is the likely result of an increase in the Earth's albedo effect?

(a) greater ozone depletion in polar regions
(b) a decrease in average global temperatures
(c) a positive increase in global energy budget
(d) a global increase in average sea levels

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.

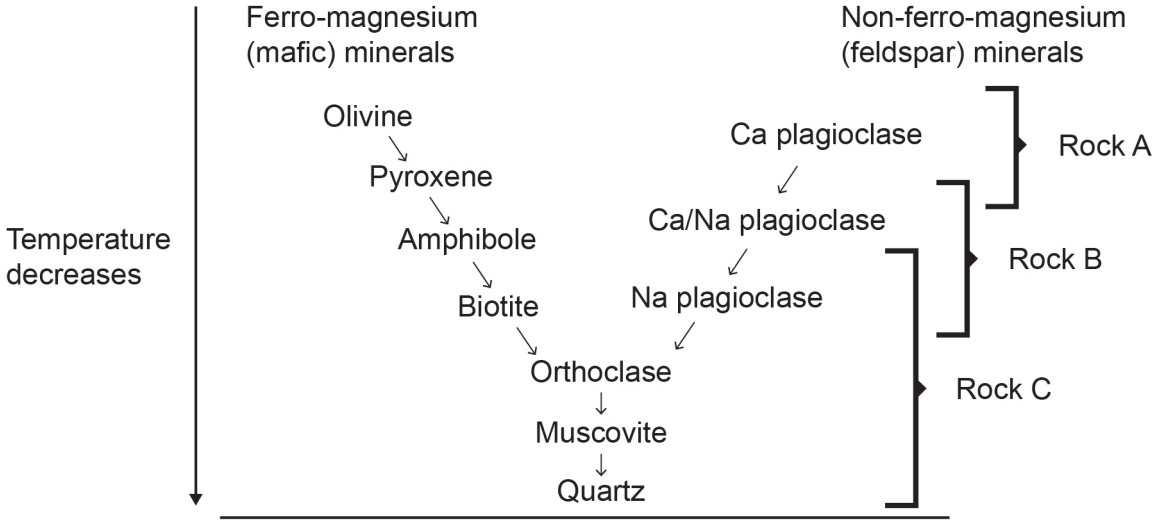
Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question that you are continuing to answer at the top of the page.

Suggested working time: 100 minutes.

Question 16 **(12 marks)**

In the early 1900s the geologist Norman Bowen conducted a number of experiments and was able to explain why certain types of minerals tended to be found together in igneous rocks, while others were almost never associated with one another. The results can be summarised in a diagram referred to as Bowen's reaction series (shown in the diagram below).



(a) The labelled brackets on the right of the diagram show the start and finish points for the crystallisation of three igneous rocks.

(i) Suggest names for each of these rocks. (3 marks)

Rock A: _____

Rock B: _____

Rock C: _____

See next page

(ii) Which **two** minerals would be the first to form in Rock A? (2 marks)

_____ and _____

(iii) Which **two** minerals would be the last to form in Rock B? (2 marks)

_____ and _____

(b) Suggest **two** reasons why quartz would **not** be found in Rock A. (2 marks)

One: _____

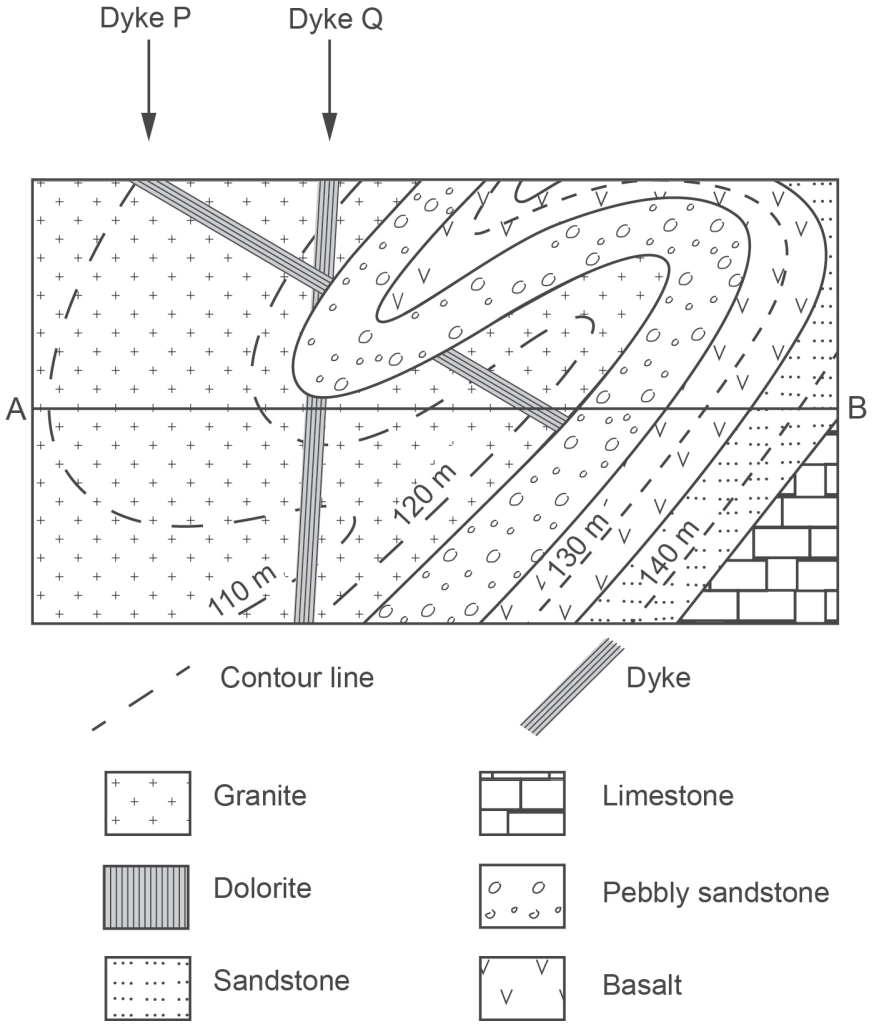
Two: _____

(c) Explain how gravitational settling in an igneous intrusion could form an ore deposit. (3 marks)

See next page

Question 17 **(14 marks)**

The geological map below was produced by a student during a field trip.



(a) On the axes provided draw a geological cross-section from Point A to Point B, to a depth of 60 m above sea level. (5 marks)

Note: to assist you to transcribe strata locations, you may remove page 37 of the booklet by tearing along the perforations.

See next page

(b) Use the information provided by the map and your cross-section to answer the following. (5 marks)

Name the oldest rock unit shown.

_____

Name the youngest rock unit shown.

_____

Which dyke is the younger? Name the geological principle that you applied to determine your answer.

Younger: _____ Principle: _____

The student noticed an erosional contact between the granite and overlying sediments. Name the specific term for this geological structure.

_____

(c) The student took samples of the granite and basalt. From these samples he had thin sections produced to observe the mineralogy of each rock under the microscope. Suggest **two** minerals that are likely to make up a large percentage of the volume of each rock. (4 marks)

Granite: _____ and _____

Basalt: _____ and _____

Question 18 **(13 marks)**

During an earthquake, rocks beneath the Earth's surface can fracture, creating joints and fault surfaces that act as fluid pathways. This fracturing dramatically increases the amount of empty space within the rocks (porosity) and the ease with which fluids can pass through them (permeability).

(a) Explain the role such fluid pathways play in the development of hydrothermal mineral systems. (3 marks)

(b) For any metallic ore deposit you have studied in Western Australia:

(i) Name the deposit, and show its location on the map provided below. (1 mark)

See next page

(ii) Describe **two** main steps involved in extracting the ore at this site and **two** stages in processing it to produce the refined resource. (4 marks)

Extracting: _____

Processing: _____

(iii) Describe **one** method applied at the mine site to reduce the environmental impact of its operations. (2 marks)

See next page

Question 18 (continued)

Geophysical surveys measure variations in rock properties beneath the surface. Because ore minerals and associated geochemical alteration are often very different in character from their host rocks, mineral systems can sometimes produce distinctive variations in geophysical response. These geophysical 'anomalies' can provide clues to help target exploration activity.

(c) For **one** geophysical survey method (seismic, magnetic, gravitational, or any other recognised technique) describe the anomalous **response** you would see produced by the type of ore deposit that you named in part (b), and the specific rock **property** responsible for this anomaly. (3 marks)

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See next page

Question 19 **(9 marks)**

The term 'biodiversity' describes the number and variety of life forms that exist and interact with each other within a given region.

(a) From a case study you have examined, describe a substantial change in biodiversity at a local or regional scale over the past 20 years. (3 marks)

(b) Describe the consequences that this change in biodiversity has had for **other** plants and/or animals in the environment. (3 marks)

See next page

(c) Suggest a human activity that either has reduced, or could reasonably be expected to reduce the change in biodiversity cited above. (3 marks)

See next page

Question 20 **(9 marks)**

In 1985, scientists published a paper in the journal *Nature* in which they reported measurements documenting the extreme local thinning, and even complete absence of, the stratospheric ozone layer (a phenomenon often referred to as the 'ozone hole').

(a) Name **one** human-made pollutant implicated in the destruction of stratospheric ozone and outline how human activities can result in the release of this pollutant. (3 marks)

(b) Describe the process by which ozone breaks down in the stratosphere. (2 marks)

See next page

(c) Outline the location (where on the planet) and during which time of the year the greatest amount of ozone depletion has been recorded. (2 marks)

Location: _____

_____

Time of year: _____

_____

(d) Describe **one** environmental consequence of reduced or zero ozone in the stratosphere. (2 marks)

_____

_____

_____

_____

_____

_____

Question 21 **(14 marks)**

The table below shows annual measurements of the carbon dioxide (CO_2) content of the atmosphere from 1970 to 2010 in ppm by volume.

Year	1970	1975	1980	1985	1995	2000	2005	2010
CO_2 (ppm)	324	328	331	346	361	370	378	386

(a) Draw a line graph of the above data, and describe in detail the main trend shown by the graph. (6 marks)

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

Trend: _____

_____

_____

See next page

(b) These measurements were collected from a research station on a mountain located on an island in the middle of the Pacific Ocean. Why would this be an ideal place to obtain accurate data? (2 marks)

(c) Give **one** explanation for the trend shown on your graph. (2 marks)

(d) Outline **two** possible environmental consequences of the trend shown on your graph. (4 marks)

One:

Two:

See next page

Question 22 **(9 marks)**

An El Niño event has a significant impact on climate in Australia.

(a) Describe a change in oceanic temperatures associated with an El Niño event. (2 marks)

(b) How does atmospheric pressure associated with an El Niño event influence the strength and direction of prevailing winds in eastern Australia? (3 marks)

(c) Describe the variation in rainfall that occurs during an El Niño event, and outline **two** consequences of this variation to eastern Australia. (4 marks)

Variation:

One:

Two:

See next page

Question 23 **(9 marks)**

Studies have shown that around 65 million years ago about 70% of all species then living on the Earth became extinct over a very short period of time. Other research has shown that the most likely cause of this extinction event was the impact of a large meteorite.

(a) Describe how the fossil record could provide evidence that an extinction event occurred. (3 marks)

(b) Describe **two** ways in which the timing of this extinction event could have been determined. (4 marks)

One:

Two:

(c) Describe **one** piece of geological evidence (**not** fossil related) that supports the conclusion that a large meteorite crashed into the Earth. How does the evidence support this conclusion? (2 marks)

See next page

Question 24 **(10 marks)**

Deep-sea hydrothermal vents, also called black smokers, were discovered in 1977 by scientists from the Scripps Institution of Oceanography.

(a) Name and describe the tectonic environment in which black smokers are formed. (3 marks)

(b) Black smokers have the ability to sustain large ecological communities (for example, giant tube worms, clams, and shrimp). Suggest how it is possible for these communities to exist in an environment that receives no sunlight. (3 marks)

See next page

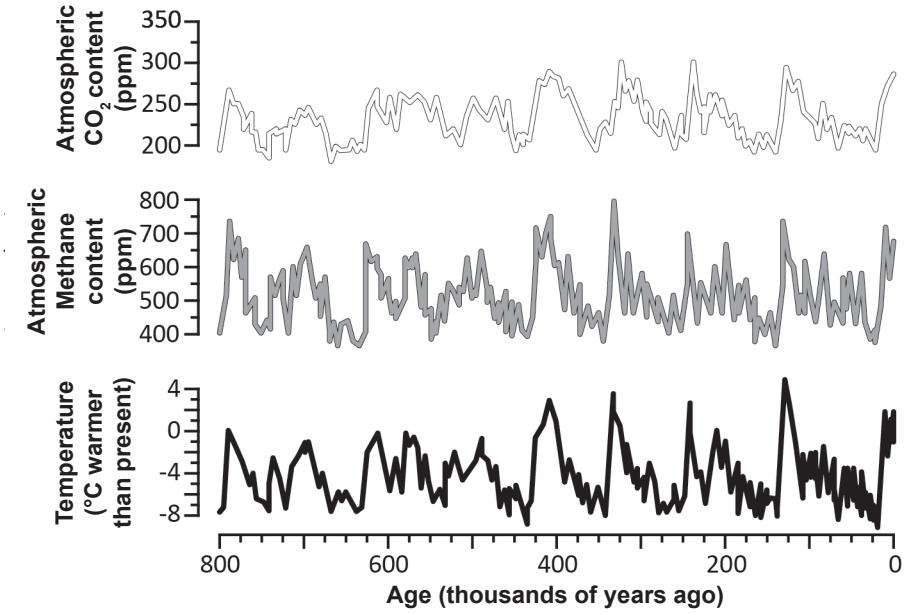
(c) With the aid of a labelled diagram, describe how black smokers can play a role in the formation of metallic ore deposits. (4 marks)

See next page

Question 25 **(11 marks)**

Geological records provide important evidence that the Earth's climate has undergone numerous change events throughout geological history.

The diagram below shows a range of climate information derived from a core sample taken from an ice sheet dating back over 800 000 years. The bottom line is a record of temperature variation over this time interval, while the other lines show the concentrations of methane (middle line) and carbon dioxide (top line) in the atmosphere over time, as recorded by gas bubbles trapped within the ice.



(a) Use the information shown on the graph to answer the following.

(i) Describe **two** variation trends or cycles apparent in this temperature record over the past 800 000 years. (2 marks)

One: _____

_____

_____

Two: _____

_____

_____

(ii) Identify when the warmest and coldest temperatures experienced in this record occurred. (2 marks)

Warmest: _____

Coldest: _____

(iii) Describe the relationship between variations in temperature and levels of methane and carbon dioxide in this record. (2 marks)

_____

_____

_____

(b) What do the data suggest about the influence of methane and carbon dioxide on global temperature? (2 marks)

_____

_____

_____

_____

_____

_____

(c) Suggest **three** possible ways in which global biodiversity could be affected if the Earth's average temperature fell by 8 °C. (3 marks)

One: _____

_____

_____

Two: _____

_____

_____

Three: _____

_____

_____

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 in the lined 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 **(15 marks)**

Metamorphism is a solid state change of one rock type to another due to the actions of heat and/or pressure. Metamorphism results in the formation of metamorphic rocks that make up a large part of the Earth's crust.

Discuss the process of metamorphism and the rocks it produces. In your answer you should:

(a) outline **two** similarities and **two** differences between contact metamorphism and regional metamorphism. (4 marks)

Use **one** metamorphic rock example in your answers to (b) and (c).

(b) describe the mineralogy and texture found in your chosen metamorphic rock. (5 marks)

(c) describe how your chosen metamorphic rock formed and suggest a tectonic environment where this might have occurred. Discuss how the mineralogy and texture of your chosen metamorphic rock might be affected by increasing the metamorphic grade. (6 marks)

See next page

Answer Question 27 or Question 28.

Question 27 **(15 marks)**

Nitrogen is one of the primary nutrients essential for all living things. The nitrogen cycle is a biogeochemical cycle that refers to the movement of this element through both biotic (biosphere) and abiotic (lithosphere, atmosphere, and hydrosphere) systems of the Earth.

Discuss the nitrogen cycle. In your answer you should:

(a) draw a labelled diagram of the nitrogen cycle. Referring to your diagram, name **two** reservoirs of this cycle. (5 marks)

(b) describe briefly **two** roles played by bacteria within the soil in the processing and transfer of nitrogen. (4 marks)

(c) discuss **two** examples of how humans alter the distribution of nitrogen and outline how these alterations have affected the natural environment. (6 marks)

or

Question 28 **(15 marks)**

Sustainability has been described as 'using natural resources in a way that benefits society without risking the availability of the resource for future generations'. Sustainable resources are becoming increasingly important to society. In Western Australia examples of ecologically sustainable resources include fisheries, forestry, groundwater, soils, and national parks.

Discuss the sustainability of **one** of these resources (or any other sustainable resource you have studied). In your answer you should:

(a) identify the resource you have chosen and describe the role of government in regulating its use. Include **two** examples of measures that are, or could be, put in place to maintain the sustainability of this resource. (5 marks)

(b) describe in detail **two** consequences of the uncontrolled use of your chosen resource on the ecology of the ecosystem of which it is part. (6 marks)

(c) outline **two** positive and **two** negative consequences of severely restricting or totally banning the use of this resource. (4 marks)

End of questions

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

You may tear along the perforations to use this page (to transcribe strata locations for Question 17).

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 17).

This page is to be used for transcribing strata locations only

Question 21 spare grid.

ACKNOWLEDGEMENTS

Section Two

Question 16 Diagram adapted from: Bowen, N.L., (2014). *Bowen's reaction series*. Retrieved from http://en.wikipedia.org/wiki/Bowen's_reaction_series. Used under a Creative Commons Attribution-ShareAlike 3.0 Unported licence.

Question 25 Diagram adapted from: Loulergue, L., Schilt, A., Spahni, R., Masson-Delmotte, V., Blunier, T., Lemieux, B., … Chappellaz, J. (2008, May 14). Orbital and millennial-scale features of atmospheric CH_4 over the past 800,000 years. *Nature*, 453, doi:10.1038, pp. 383–385.

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