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

WACE
Western Australian Certificate of Education

Western Australian Certificate of Education Examination, 2015

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: 15-037

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 2015*. 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. The segregation and removal of early formed crystals from magma is called

   (a) magnetic separation.
   (b) fractional crystallisation.
   (c) immiscible liquid separation.
   (d) metasomatism.

2. The excessive use of nitrogen-based fertilisers is a major contributor to which of the following environmental issues?

   (a) dryland salinity
   (b) ozone depletion
   (c) enhanced greenhouse effect
   (d) eutrophication

3. Which of the following gases is **most** likely to contribute to the formation of the environmental impact called acid rain?

   (a) carbon dioxide
   (b) chlorofluorocarbon (CFC)
   (c) sulfur dioxide
   (d) methane

4. Which of the following is the **most** likely tectonic environment for the formation of black smokers?

   (a) subduction zone
   (b) continental-continental collision zone
   (c) intra-continental rift zone
   (d) mid-oceanic ridge

5. Which of the following is **least** likely to result from global warming?

   (a) the thinning of Arctic sea ice in summer months
   (b) an increase in the number and severity of tropical cyclones
   (c) a decrease in the rate of photosynthesis by vegetation
   (d) the inundation of low-lying areas by seawater

See next page

6. Areas near the coast may experience a local wind called a sea breeze. Which of the following **best** describes the environmental conditions during a sea breeze?

(a) cooler higher-pressure air over the ocean and warmer lower-pressure air over the land
(b) warmer higher-pressure air over the ocean and cooler lower-pressure air over the land
(c) cooler lower-pressure air over the ocean and warmer higher-pressure air over the land
(d) warmer lower-pressure air over the ocean and cooler higher-pressure air over the land

7. Land degradation would be **best** defined as the

(a) over exploitation of the Earth's limited natural resources.
(b) deterioration in land quality due to excessive exploitation.
(c) build-up of salts in the soil surface in non-irrigated areas.
(d) improper disposal of residential and industrial waste.

8. In which of the following lists of atmospheric pollutants do all three examples contain particulates?

(a) smog, bushfire smoke, dust
(b) carbon monoxide, smog, volcanic ash
(c) volcanic ash, ozone, cigarette smoke
(d) dust, chlorofluorocarbons, carbon dioxide

9. The **most** pronounced ozone depletion occurs within the

(a) troposphere above low latitude regions during summer.
(b) stratosphere above polar regions during autumn.
(c) troposphere above low latitude regions during winter.
(d) stratosphere above polar regions during spring.

10. The **most** widespread human-made pollutant in the world's oceans is

(a) dissolved nitrogen-based fertiliser.
(b) crude oil.
(c) particles of plastic.
(d) raw sewage.

See next page

11. Approximately 30% of the incoming solar energy that reaches the Earth is reflected directly back into space. Which of the following is the **main** cause of this reflection?

(a) ice sheets
(b) sea ice
(c) the upper atmosphere
(d) clouds

12. Which of the following would be a likely consequence of increased water temperatures in the Southern Ocean between Australia and Antarctica?

(a) decreased ozone levels in the southern polar regions
(b) southerly movement of warm-water marine species habitat boundaries
(c) decreased rainfall in the south-west of Western Australia
(d) increased oxygen levels in the Southern Ocean

13. Imagine that a geological map predicts the presence of limestone at your location. On investigating the rocks, you find that the area is entirely underlain by basalt instead. Which of the following statements **best** describes the scientific implications of this observation?

(a) Basalt is an extrusive igneous rock with a low silica content.
(b) The distribution of rocks predicted by the map has been proved false.
(c) Limestone can be metamorphosed into basalt over time.
(d) Navigation in wilderness areas can be challenging.

14. Which of the following factors is the **most** important factor in dynamic metamorphism?

(a) high differential stress
(b) low to moderate confining pressure
(c) low geothermal gradients
(d) moderate to high temperatures

15. Which property of rocks is measured by a geophysical gravity survey?

(a) age
(b) magnetic susceptibility
(c) density
(d) conductivity

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 **(11 marks)**

(a) Describe briefly the tectonic environment associated with regional metamorphism. (3 marks)

(b) Name **two** metamorphic rocks that are commonly formed by regional metamorphism, and suggest a parent rock (protolith) for each. (4 marks)

One: _____

Protolith: _____

Two: _____

Protolith: _____

(c) Describe **two** textural or mineralogical features that would indicate that the metamorphic rock was formed by regional metamorphism. (4 marks)

One: _____

_____

_____

_____

Two: _____

_____

_____

_____

Question 17 **(10 marks)**

The Earth's energy budget describes the balance between energy entering the atmosphere from space and energy leaving the atmosphere back into space.

(a) Explain why incoming radiation from the Sun results in the heating of equatorial regions more than polar regions. (2 marks)

(b) Name **one** Australian oceanic current you have studied and describe how this current affects the distribution of the Earth's energy. (4 marks)

Name: _____

Description: _____

See next page

(c) Describe **two** ways through which this current affects the climate of the region in which it occurs. (4 marks)

One: _____

_____

_____

_____

Two: _____

_____

_____

_____

Question 18 **(12 marks)**

An introduced species is a species living outside its native range, due to human activity, either deliberate or accidental. Many introduced species are recognised in the Australian landscape and they often disrupt local ecosystems.

(a) Provide **one** example of an introduced species that is recognised as a pest in Australia and indicate one specific area or ecosystem in which this species affects the Australian environment. (2 marks)

Example: _____

_____

Area/ecosystem: _____

_____

_____

_____

(b) Explain how your chosen species was first introduced into the Australian environment. (2 marks)

_____

_____

_____

_____

_____

(c) Describe **two** ways in which this introduced species has a negative impact on specific native plants and animals. (4 marks)

One: _____

Two: _____

(d) Describe **two** control measures that have been (or could reasonably be) used to reduce the negative impacts of this introduced species on the native environment. (4 marks)

One: _____

Two: _____

See next page

Question 19 **(12 marks)**

Chlorofluorocarbons (CFCs) are chemical compounds that contain only carbon, chlorine and fluorine. CFCs are known to be responsible for ozone depletion. In 1989, an international treaty (the Montreal Protocol) was implemented to protect the ozone layer by phasing out the production of ozone-depleting substances such as CFCs. The table below shows Australia's total CFC consumption for the years 1990 to 2000.

Year	Total CFC consumption (tonnes)
1990	7778
1993	5310
1994	3954
1995	2839
1996	252
1998	195
2000	10

(a) Using the grid on page 13, draw a line graph of the data in the table above. (4 marks)

(b) Describe **two** trends shown by the data. (4 marks)

One: _____

_____

_____

_____

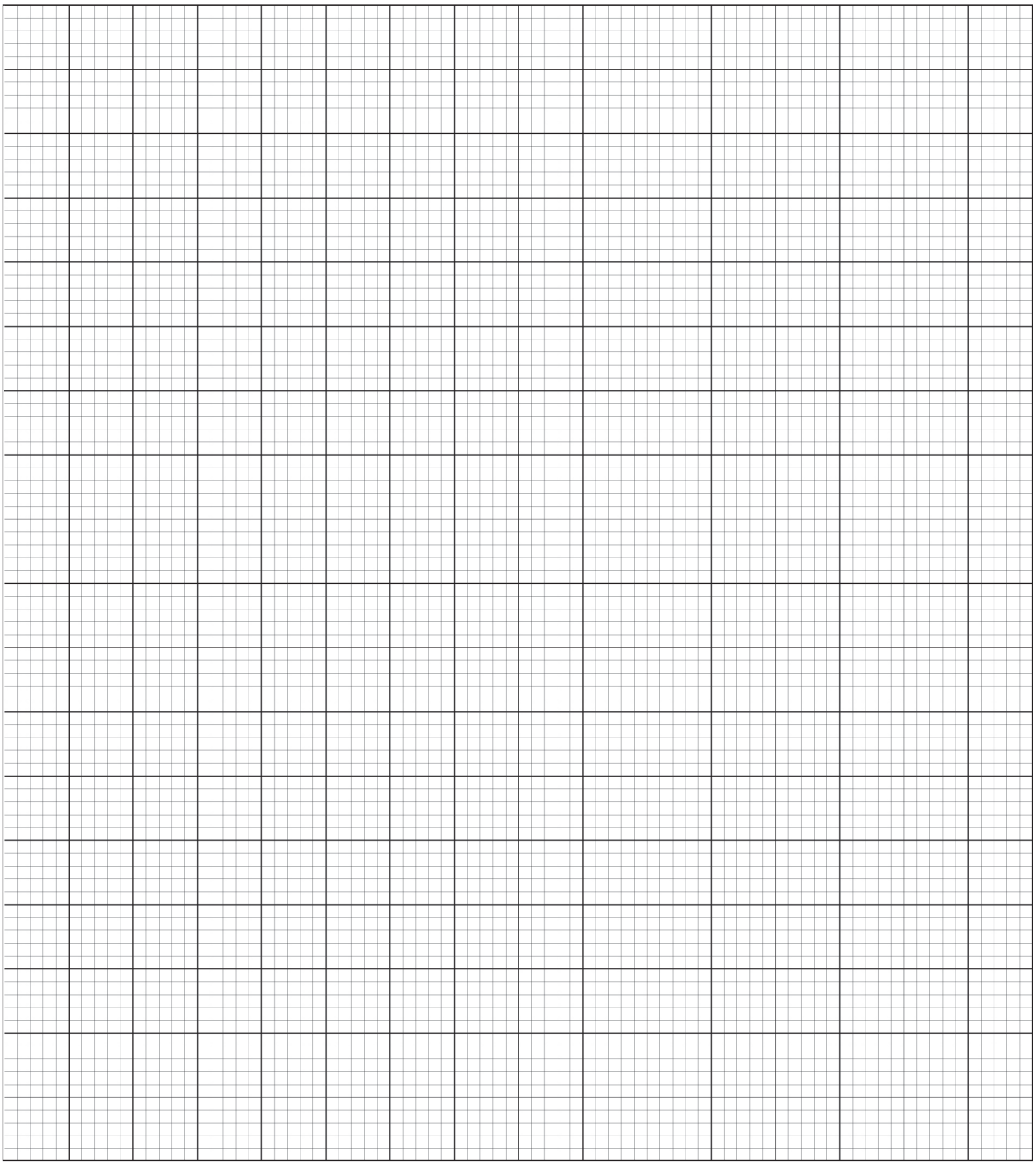
Two: _____

_____

_____

_____

See next page



If you wish to make a second attempt, the grid is repeated at the back of this Question/Answer Booklet. Indicate clearly on this page if you have used the second grid and cancel the working of the grid on this page.

See next page

Question 19 (continued)

(c) Name **one** source of CFCs that was common prior to the Montreal Protocol, and describe how CFCs contributed to the destruction of stratospheric ozone. (4 marks)

Source: _____

Description: _____

_____

_____

_____

_____

_____

_____

Question 20 **(9 marks)**

Explain briefly **one** way in which each of the following past geological events may have caused changes to Earth's climate.

(a) An extended period of widespread volcanic activity that released large volumes of dust into the atmosphere (3 marks)

(b) Plate movement that caused two continents to collide, leading to the formation of a large mountain range (3 marks)

(c) An extended cold period that resulted in increased snow in the northern polar region and the expansion of polar ice caps and glaciers (3 marks)

See next page

Question 21 **(13 marks)**

(a) Describe **two** ways in which the textures found in igneous rocks differ from those found in sedimentary rocks. (4 marks)

One: _____

_____

_____

_____

Two: _____

_____

_____

_____

Igneous rocks can be classified into four main groups: felsic, intermediate, mafic and ultramafic.

(b) Name **one** felsic igneous rock and **one** mafic igneous rock. (2 marks)

Felsic: _____

Mafic: _____

See next page

(c) Name **two** minerals that are commonly found in each of these rock types. (4 marks)

Felsic: _____ and _____

Mafic: _____ and _____

(d) Describe **one** example of how plate tectonic processes influence the distribution of igneous rocks on the Earth's surface. (3 marks)

_____

_____

_____

_____

_____

_____

_____

_____

Question 22 **(10 marks)**

Biomass is the biological material that makes up living organisms. On the continents the greatest volume of biomass occurs in forests. Human activity has caused a significant biomass loss in Australia's primary (old growth) forests. Data indicate that most countries had similar losses of 1% to 6% of total biomass between the years 2000 and 2005.

(a) List **three** reasons why forests may have been cleared. (3 marks)

One: _____

Two: _____

Three: _____

(b) Describe briefly **two** different methods by which humans have cleared large areas of forest. (4 marks)

One: _____

_____

_____

_____

Two: _____

_____

_____

_____

(c) Describe **three** ways in which the removal of large volumes of biomass has affected the global balance of carbon. (3 marks)

One: _____

_____

_____

Two: _____

_____

_____

Three: _____

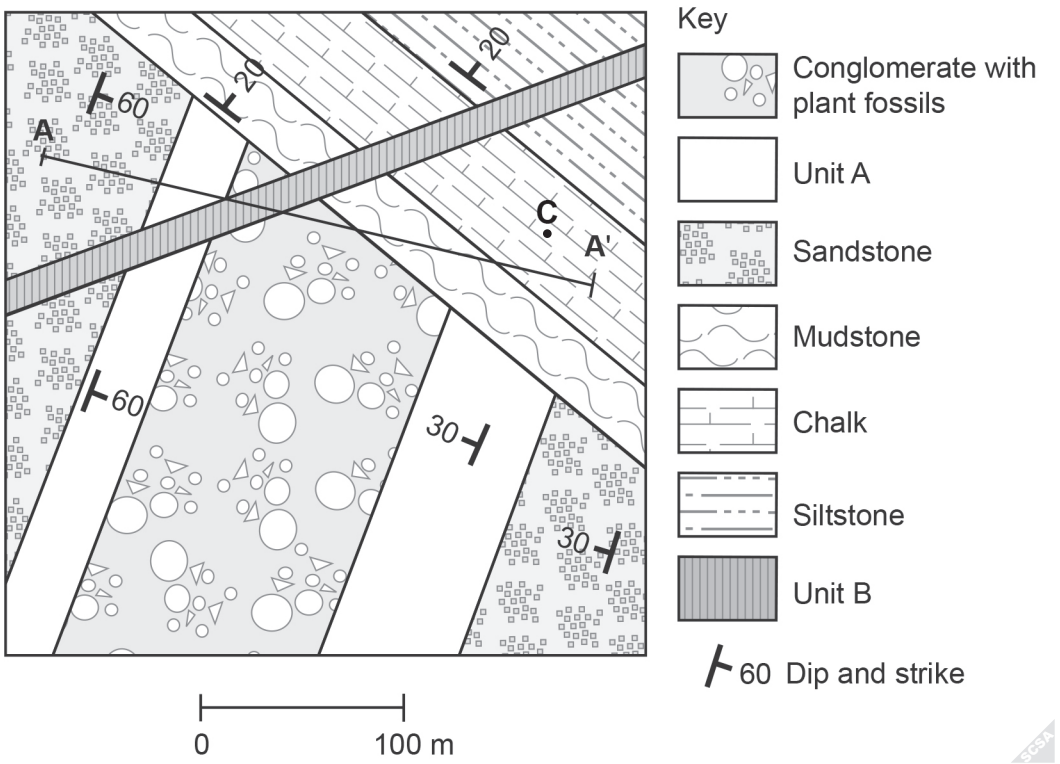
_____

_____

Question 23 **(14 marks)**

A group of students is exploring the field geology of the region shown on the map below, describing the lithologies encountered and taking structural measurements.

(a) Use the axis provided to produce a cross-section along the line A–A' to illustrate the geological relationships of this region below the surface. Your section should be constructed with no vertical exaggeration (equal horizontal and vertical scales). (6 marks)



Note: to assist you to transcribe strata locations, you may remove page **41** of the booklet by tearing along the perforations.

See next page

(b) Use the information shown on the map and your cross-section to answer the following: (4 marks)

Which of the mapped units does **not** appear on your cross-section?

Which of the units mapped in this area is the oldest?

Which unit is the youngest?

Name the type of structure formed by Unit B.

(c) If a 100 m deep hole was drilled at Point C, which of the mapped units would be encountered in the drill core? In what order would they be observed (from top to bottom)? (2 marks)

See next page

Question 23 (continued)

(d) The students noticed that within Unit A, there was a thin zone of contact metamorphism along the contact between Unit A and Unit B. In the altered zone, all original sedimentary structure had been destroyed and replaced with a mineralogy consisting of coarse, interlocking quartz crystals. (2 marks)

Suggest a name for the metamorphic rock produced in the altered zone.

Suggest a name for Unit A (the protolith).

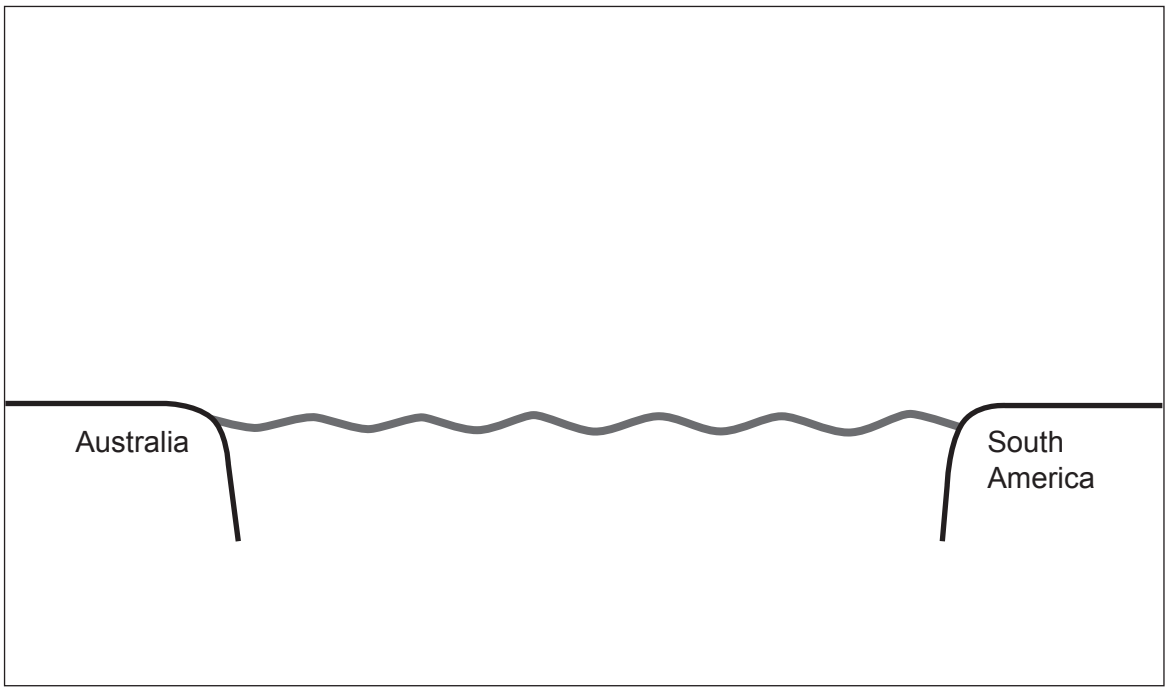
See next page

Question 24 **(9 marks)**

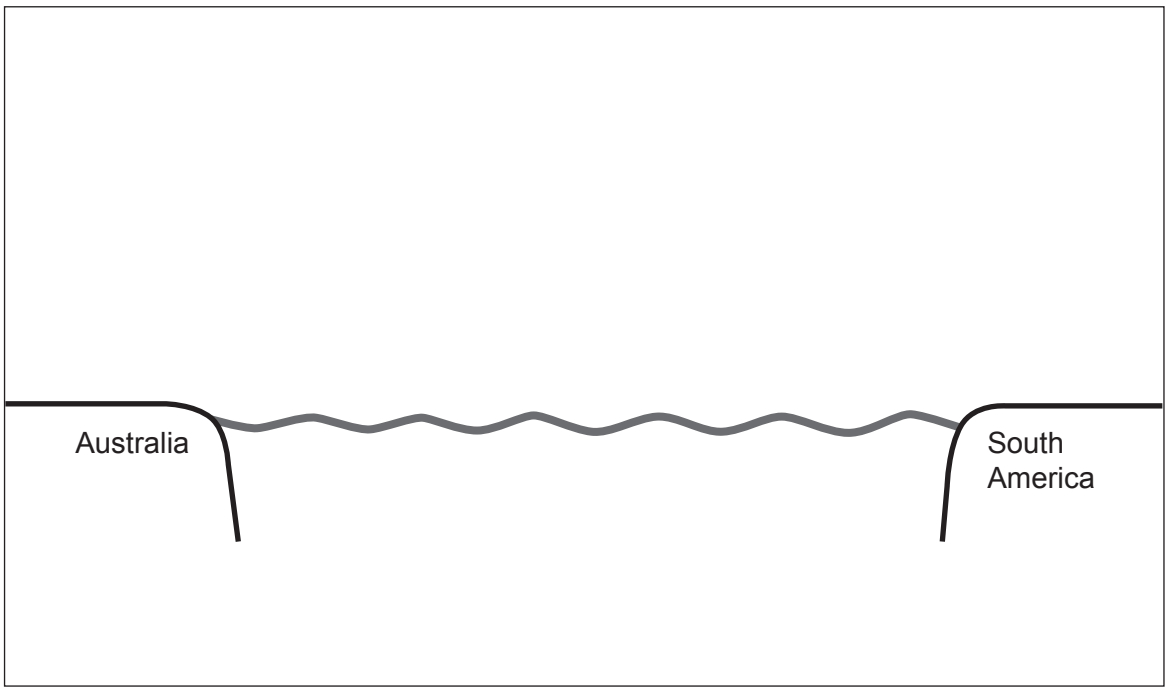
El Niño and La Niña are linked fluctuations in the surface water temperatures of the tropical Pacific Ocean and the atmosphere above it that result in significant temporary climatic changes.

(a) Complete the diagrams below to show the location of the warmer water, the patterns of air movement over the ocean and regions of heaviest rainfall for an El Niño event and a La Niña event. (6 marks)

El Niño



La Niña



See next page

Question 24 (continued)

(b) Describe briefly **three** changes to the weather in eastern Australia that occur during an El Niño event. (3 marks)

One: _____

_____

_____

Two: _____

_____

_____

Three: _____

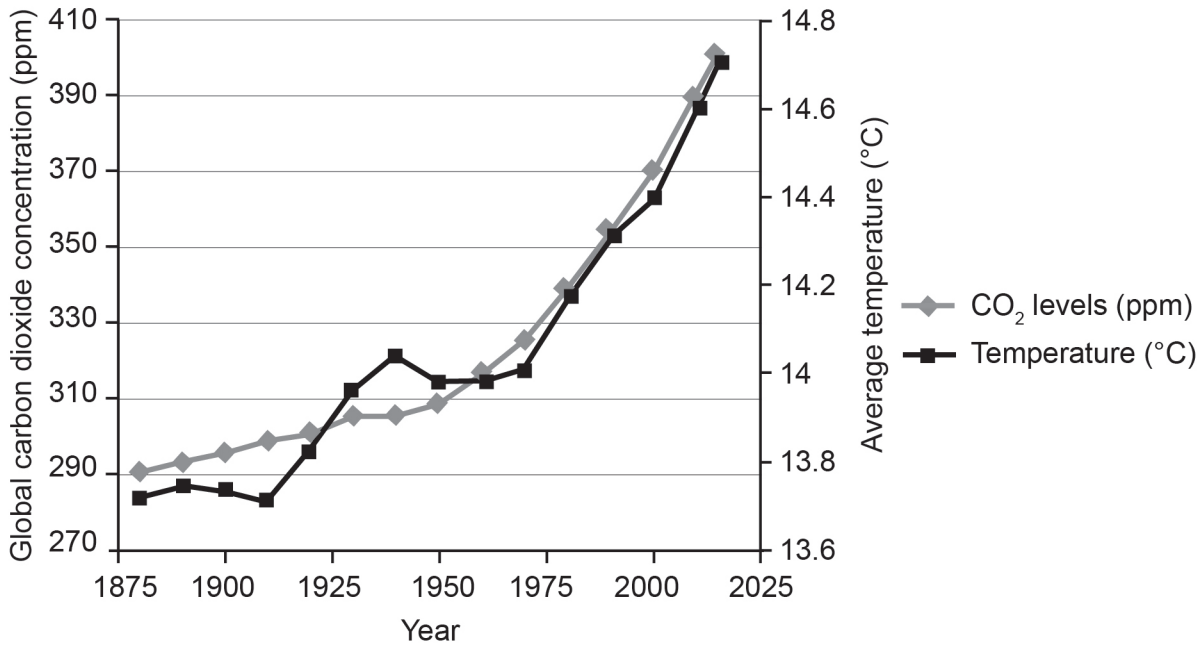
_____

_____

Question 25 **(10 marks)**

The following graph shows changes in the Earth's lower atmosphere since 1880.

Global carbon dioxide and average temperature levels



See next page

(a) Describe the **two** main changes to the Earth's lower atmosphere that are shown in the graph. (2 marks)

One: _____

_____

Two: _____

_____

(b) Suggest **one** possible cause for the trend in carbon dioxide levels shown in the graph. (2 marks)

_____

_____

_____

_____

(c) With the aid of a diagram, provide a possible explanation for the relationship between the carbon dioxide and temperature levels shown in the graph. (6 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 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)**

Metals are among the most significant resources found within the Earth. Igneous processes often play a substantial role in the formation of metallic mineral deposits.

(a) Describe, with the use of a labelled diagram, how igneous processes could lead to the development of an economic metal deposit. (6 marks)

(b) Describe **one** geophysical method (reflection seismic, magnetic, gravitational or any other recognised technique) that could be used to explore for metallic mineral deposits and the geophysical response you would expect from the method. (4 marks)

(c) For a metallic ore deposit you have studied in Western Australia, name the deposit, identify the metallic resource produced and outline the steps involved in extracting the ore and processing it to produce the refined resource. (5 marks)

See next page

Question 27 **(15 marks)**

The mining and processing of an ore deposit has the potential to produce pollution that may adversely affect the health of the surrounding population and alter the local ecosystem. Discuss the production and effects of such pollution.

In your answer, you should:

(a) Describe **two** possible sources of pollution with the potential to produce adverse health effects that might be produced by the mining and processing of an ore deposit. (4 marks)

(b) Describe possible health impacts that might result from each of the pollution sources described in (a) and suggest a method that could be used to reduce the impact of each of the pollution sources. (6 marks)

(c) Define what is meant by the term 'environmental sustainability' and describe one way in which mine-related pollution could affect the sustainability of the local ecosystem. (5 marks)

or

Question 28 **(15 marks)**

A banded iron formation (BIF) is a distinctive type of sedimentary rock that can be an important commercial source of iron ore, such as the large deposits found in the Pilbara region of Western Australia. Discuss the formation and development of a BIF.

In your answer, you should:

(a) Describe, with the aid of a diagram or flow chart, the formation of a BIF. (8 marks)

(b) Explain why banded iron formations almost exclusively formed in the Precambrian period (between 2400 and 1900 million years ago) and how their formation would have affected the chemical composition of the oceans and the atmosphere. (4 marks)

(c) Describe a natural process that could enrich the iron content of a BIF (typically 30-35% by weight) to the level required for economic iron deposits (typically 55% by weight). (3 marks)

End of questions

Question number: _____

Question number: _____

Question number: _____

Question number: _____

Question number: _____

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Additional working space

Question number: _____

Additional working space

Question number: _____

Additional working space

Question number: _____

You may tear along the perforations to use this page (to transcribe strata locations for Question 23).

This page is to be used for transcribing strata locations only

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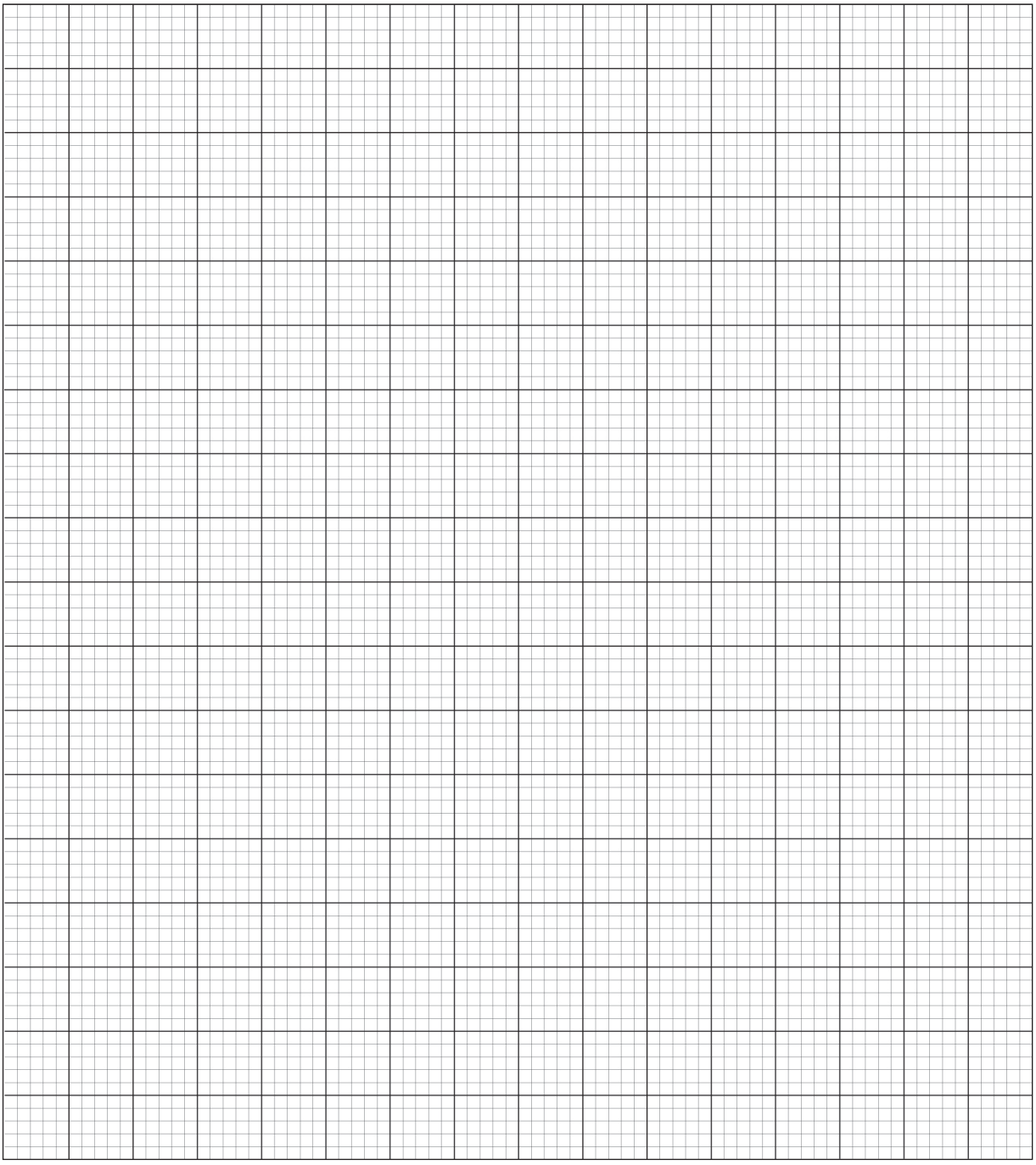
This page is to be used for transcribing strata locations only

Question 19 spare grid.



ACKNOWLEDGEMENTS

Section Two

Question 19

Adapted from: Australian Government. Department of the Environment. (2001, October). *CFC consumption 1990 to 2000* [Table]. (Original data source estimated from UNEP [1999]) Retrieved May, 2015, from www.environment.gov.au/system/files/resources/3b6cedc5-68dc-40c9-ba9e-8358484bb95a/files/cfcms.pdf Used under the Creative Commons Attribution 4.0 International licence.

Question 25

Data source (temperature): Bureau of Meteorology (n.d.). *Global carbon dioxide and average temperature levels* [Graph]. Retrieved May, 2015, from www.bom.gov.au/climate/change/

Data source (carbon dioxide): Keeling, R.F., Piper, S.C., Bollenbacher, A.F., & Walker, S.J. (2009, February). *Global carbon dioxide and average temperature levels* [Graph]. Courtesy of Oak Ridge National Laboratory, U.S. Department of Energy. Retrieved May, 2015, from http://cdiac.ornl.gov/ftp/trends/co2/maunaloa.co2

Published by the School Curriculum and Standards Authority of Western Australia
303 Sevenoaks Street
CANNINGTON WA 6107