

STUDENT NUMBER Letter

ENVIRONMENTAL SCIENCE

Written examination

Friday 16 November 2018

Reading time: 3.00 pm to 3.15 pm (15 minutes)

Writing time: 3.15 pm to 5.15 pm (2 hours)

QUESTION AND ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	30	30	30
B	9	9	90
			Total 120

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

- Question and answer book of 26 pages
- Answer sheet for multiple-choice questions

Instructions

- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions**Instructions for Section A**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Use the following information to answer Questions 1 and 2.

A rainforest tree that produces fruit is endemic to eastern Africa. This tree relies on a native bird species for survival. Population numbers of both the tree and the bird have declined in recent years.

Question 1

Which type of service is the native bird likely to be providing for the fruiting tree?

- A. air purification
- B. water recycling
- C. dispersal of seeds
- D. competition for resources

Question 2

One proposal to manage the decline of the rainforest tree is to introduce many individuals of a species of African bird that is not native to the area in which the tree grows. Scientists have argued against this proposal as there is a risk that the introduced bird could compete with native birds in the area.

This argument against the proposal is based on which of the following ideas?

- A. habitat regeneration
- B. anthropocentric values
- C. intragenerational equity
- D. the precautionary principle

Question 3

Ecosystems affect humans in a variety of ways. One example is the role of nitrogen-fixing bacteria in converting atmospheric nitrogen into other compounds for use by plants as part of the nitrogen cycle.

Which type of service is the nitrogen cycle providing in this example of an ecosystem?

- A. controlling
- B. supporting
- C. provisioning
- D. diversity

Question 4

The current species extinction rate is significantly higher than the average historical global extinction rate.

This higher rate is due to the

- A. ability of many species to survive the impacts of climate change.
- B. unsuccessful attempts by humans to implement a variety of conservation strategies.
- C. collective impacts of the human population on a wide variety of ecosystems over a relatively short time scale.
- D. isolation of populations over time due to short-term changes, such as volcanic eruptions, and longer-term changes, such as tectonic plate movements.

Question 5

The Tasmanian devil ranged across the Australian mainland until around 400 years ago. The species no longer exists on the mainland and can be found in the wild only on the island of Tasmania.

Therefore, the Tasmanian devil

- A. is extinct in Australia.
- B. is endemic to Tasmania.
- C. has increased its geographic range.
- D. was subject to a mass extinction event on the mainland.

Question 6

Studies of the Tasmanian devil population have shown that the species has very low genetic diversity.

This is likely to lead to

- A. a high survival rate for the species.
- B. a wide variety of morphological features.
- C. limited ability of the population to withstand any rapid environmental change.
- D. an increase in the Tasmanian devil population as the species is forced to adapt to changes in its habitat.

DO NOT WRITE IN THIS AREA

Use the following information to answer Questions 7–9.

Two different species are being studied. The mustard-bellied snake (*Drysdalia rhodogaster*) is found only in eastern New South Wales and is a close relative of the Masters' snake (*Drysdalia mastersii*), which inhabits southern Australia and includes populations in western Victoria. Currently the Masters' snake is listed as a threatened species under the *Flora and Fauna Guarantee Act 1988* (Vic). The International Union for Conservation of Nature (IUCN) Red List of Threatened Species includes the Masters' snake at the level of 'least concern' on its classification scale.

Question 7

Which one of the following is the correct explanation for the two different conservation ratings for the Masters' snake species?

- A. Both ratings are valid because they account for scientifically collected population data over different regions.
- B. The IUCN classification is more valid because data has been collected over a wider area than just Victoria.
- C. The IUCN classification is less valid because the IUCN is an international organisation and has less understanding of Australian species.
- D. The *Flora and Fauna Guarantee Act 1988* (Vic) classification is invalid because it does not take into account total population numbers throughout Australia.

Question 8

To try and re-establish numbers of the Masters' snake in the wild, it has been suggested that a captive-breeding program be established. Masters' snakes from South Australia are to be mated with the related species, the mustard-bellied snake.

A captive-breeding program would

- A. be a useful way of increasing numbers, due to increased mating opportunities.
- B. not work because although the snakes are closely related they are not the same species.
- C. not be a suitable idea because genetic swamping may occur if the population sizes are different.
- D. be improved if captive breeding between the two populations was carried out under carefully controlled conditions and any offspring were released into suitable habitats.

Question 9

Protecting the known habitat of the Masters' snake throughout western Victoria has been suggested as a more suitable way of valuing the entire unique ecosystem (both the living and non-living components) of this region.

This view would be regarded as

- A. ethical.
- B. biocentric.
- C. ecocentric.
- D. anthropocentric.

Question 10

The concept of intergenerational equity is best illustrated by which one of the following scenarios?

- A. providing veterinary care in a zoo
- B. protecting World Heritage areas from deforestation
- C. donating an equal sum of money to all citizens of a country
- D. consulting community business owners before approving the creation of an open-cut mine

Use the following information to answer Questions 11 and 12.

An environmental science project aims to minimise the impact of a planned development on the upper soil and rock layers of Earth's crust. Before the development is approved, an environmental risk management plan is required.

Question 11

Which one of Earth's systems is the key focus of this project?

- A. biosphere
- B. lithosphere
- C. atmosphere
- D. hydrosphere

Question 12

What is the main purpose of producing an environmental risk management plan?

- A. to provide local residents with information to use in the decision-making and approval process
- B. to scientifically investigate, identify and record all possible negative impacts on the environment
- C. to identify and evaluate what environmental risks exist and then determine how to best manage those risks to protect human health and the environment
- D. to plan how to overcome the economic and social impacts of any planned development so that future generations are not negatively affected

Question 13

The complete combustion of natural gas produces

- A. methane and ozone.
- B. oxygen and nitrogen.
- C. various hydrocarbons.
- D. carbon dioxide and water vapour.

Question 14

Which one of the following lists contains only non-fossil energy sources?

- A. coal, nuclear, natural gas, wind
- B. nuclear, hydro-electric, wind, solar
- C. hydro-electric, solar, wind, natural gas
- D. nuclear, hydro-electric, oil, wind

Question 15

Which one of the following lists contains only renewable energy sources?

- A. nuclear, natural gas, wind, coal
- B. nuclear, natural gas, wind, solar
- C. hydro-electric, solar, wind, tidal
- D. hydro-electric, solar, wind, natural gas

DO NOT WRITE IN THIS AREA

Question 16

Which of the following factors are required for the formation of fossil fuels?

- A. decaying organic material, heat, pressure
- B. oceans, layers of sediment, millions of years
- C. plant and animal matter, heat, thousands of years
- D. swamp plants, combustion, carbon dioxide, millions of years

Question 17

Which of the following energy transformations takes place in a hydro-electric power station?

- A. heat → kinetic → electrical
- B. chemical → heat → electrical
- C. gravitational potential → heat → electrical
- D. gravitational potential → kinetic → electrical

Question 18

The steam turbine section of a gas-fired thermal power station has an input power of 200 MW and an output into the generator of 160 MW.

What is the percentage efficiency of the steam turbine?

- A. 125%
- B. 80%
- C. 16%
- D. 0.80%

Question 19

Which one of the following is a disadvantage of solar compared to hydro-electricity as an energy source for the generation of electricity?

- A. Solar cannot generate electricity 24 hours a day.
- B. Solar is less accessible compared to hydro-electric energy sources.
- C. Solar is a non-renewable source whereas hydro-electricity is a renewable source.
- D. Solar can be used by home owners with solar panels and a backup storage system.

Question 20

Earth's orbit around the sun does not follow a perfect circle.

This is known as Earth's

- A. tides.
- B. axial tilt.
- C. precession.
- D. eccentricity.

Question 21

Which one of the following lists the gases in Earth's atmosphere from greatest concentration to lowest concentration?

- A. oxygen, neon, methane, nitrogen
- B. nitrogen, oxygen, argon, carbon dioxide
- C. carbon dioxide, oxygen, methane, xenon
- D. nitrogen, methane, sulfur dioxide, oxygen

Question 22

Increasing concentrations of atmospheric carbon dioxide are causing

- A. acidification of the oceans.
- B. expansion of the ozone layer.
- C. a rise in atmospheric density.
- D. increased saltiness of the world's oceans.

Question 23

Methane has a global warming potential that is approximately 30 times that of carbon dioxide, yet methane lasts in the atmosphere for less time than carbon dioxide.

Methane's greater global warming potential is due to

- A. methane's high flammability.
- B. the extensive natural sources of methane gas.
- C. the time that methane molecules last in the atmosphere.
- D. methane molecules absorbing more infra-red radiation than carbon dioxide molecules.

Question 24

Climate scientists have high confidence that average temperatures will continue to increase. They have medium confidence that droughts in Australia will get longer.

Which one of the following statements can be inferred from this information?

- A. It is certain that droughts in Australia will get shorter.
- B. It is certain that average temperatures will rise in the future.
- C. The trends in past changes to temperature are weaker than the trends in past changes to droughts.
- D. Climate scientists are less certain about the future lengths of droughts than they are about average temperatures rising.

Question 25

Which one of the following is an impact of climate change on the lithosphere?

- A. faster plant growth
- B. more frequent downpours
- C. coastal erosion due to rising sea levels
- D. changes to the temperature of the stratosphere

DO NOT WRITE IN THIS AREA

Question 26

Which one of the following is an example of carbon sequestration?

- A. burning crop waste instead of burying it in soil
- B. adding iron to the oceans to enhance plankton growth
- C. replacing coal-burning power stations with solar power stations
- D. monitoring programs that measure the amount of carbon dioxide in the atmosphere

Question 27

Which one of the following is **unlikely** to be an impact of climate change?

- A. greater frost damage
- B. more days of extreme heat
- C. changes to rainfall patterns
- D. changes to tropical cyclones

Use the following information to answer Questions 28–30.

A group of VCE Environmental Science students sets up an experiment to test the hypothesis that ‘an increase in carbon dioxide concentration increases water temperature’. The students set up 1.0 L beakers of salt water and then dissolved carbon dioxide in the salt water in different concentrations. They measured the changes in water temperature over a period of 10 minutes using a thermometer. The experiment was repeated 10 times and an average of the initial and final temperatures was calculated.

Question 28

Which one of the following factors could best have improved the accuracy of the students’ results?

- A. The experiments were conducted at night.
- B. A 1.0 mL drop of water from one of the beakers was spilt on the floor.
- C. The temperature of the science laboratory was kept constant throughout the testing period.
- D. Human error when reading the thermometer caused some temperature readings to be slightly higher and some temperature readings to be slightly lower for each beaker.

Question 29

Control beakers containing no carbon dioxide were also set up.

These control beakers were used to

- A. ensure the experimental results were precise.
- B. provide a comparison with the true or correct result.
- C. ensure the same conditions were present in every repeat experiment.
- D. provide a comparison to ensure results were due to the variable the experimenter was changing.

Question 30

After conducting the experiment, the students found that there was no change in temperature with increased carbon dioxide concentrations.

Which one of the following is correct?

- A. The experiment was invalid.
- B. The data collected was qualitative.
- C. The students' hypothesis was not supported.
- D. The same results will not be obtained when conducting the experiment again and therefore the results are unreliable.

DO NOT WRITE IN THIS AREA

**END OF SECTION A
TURN OVER**

SECTION B**Instructions for Section B**

Answer **all** questions in the spaces provided. Write using blue or black pen.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (10 marks)

Scientists are concerned about the low diversity of reptile species in the semi-arid regions of north-west Victoria. The scientists collected the data in the table below over a two-week period during late November in a large national park. Simpson's Index of species diversity (D) was calculated by the scientists in order to compare the diversity of reptile species at two sites (X and Y). The index (D) can be calculated using the following formula.

$$\text{Simpson's Index: } D = 1 - \frac{\sum[n_i(n_i - 1)]}{N(N - 1)}$$

Note: \sum refers to the 'sum of'

n_i means the total number of organisms of each individual species

N means the total number of organisms of all species

A higher index value indicates greater species diversity.

Reptile species trapped at Site X	n_i	$n_i - 1$	$n_i(n_i - 1)$
painted dragon	35	$35 - 1 = 34$	$35 \times 34 = 1190$
wood gecko	34	$34 - 1 = 33$	$34 \times 33 = 1122$
delicate skink	7	$7 - 1 = 6$	$7 \times 6 = 42$
eastern striped skink	7	$7 - 1 = 6$	$7 \times 6 = 42$
stump-tailed lizard	25	$25 - 1 = 24$	$25 \times 24 = 600$
Mitchell's short-tailed snake	23	$23 - 1 = 22$	$23 \times 22 = 506$
bardick snake	5	$5 - 1 = 4$	$5 \times 4 = 20$
$N =$	136		$\sum[n_i(n_i - 1)] = 3522$
$N(N - 1) =$	18 360		

Therefore
$$D = 1 - \frac{\sum[n_i(n_i - 1)]}{N(N - 1)}$$

$$D = 1 - \frac{3522}{18\,360}$$

$$D = 1 - 0.192$$

$$D = 0.808$$

Simpson's Index (D) for Site X is 0.808

- a. Use the figures in the table below and the spaces provided to calculate Simpson's Index (D) for Site Y. 3 marks

Reptile species trapped at Site Y	n_i	$n_i - 1$	$n_i(n_i - 1)$
painted dragon	33		
wood gecko	30		
delicate skink	5		
eastern striped skink	26		
stump-tailed lizard	22		
Mitchell's short-tailed snake	9		
bardick snake	4		
N =			$\sum[n_i(n_i - 1)] =$
N(N - 1) =			

Therefore
$$D = 1 - \frac{\sum[n_i(n_i - 1)]}{N(N - 1)}$$

$$D = 1 - \frac{\quad}{\quad}$$

$$D = 1 - \frac{\boxed{\quad}}{\quad}$$

Simpson's Index (D) for Site Y is $\boxed{\quad}$.

- b. Compare the species diversity of Site X and Site Y as indicated by the Simpson's Index (D) calculations. 2 marks

- c. Explain what the information from the two tables indicates about the species richness at Site X and Site Y, making clear what the term ‘species richness’ means. 2 marks

- d. In order to try to collect more data on the bardick snake, the scientists decide to return to the national park and conduct a mark-recapture sampling method on this snake species.

What is the purpose of using this method? 1 mark

- e. Identify and justify **one** appropriate health and safety guideline that the team of scientists would need to follow when conducting the capture of these reptiles in this national park. 2 marks

DO NOT WRITE IN THIS AREA

Question 2 (7 marks)

A species of native Australian frog inhabits wetlands and surrounding woodlands in New South Wales. At present, the entire population of these frogs in the wild is estimated to be fewer than 50 individuals. The wild population has declined by more than 99 per cent since 1988. There are several populations in captivity.

- a. Identify an appropriate conservation category for this frog species based on the classification conditions outlined by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. Explain why this classification would be given. 2 marks

- b. There has been a decrease in the fertility of frogs within the remaining population in the wild. What is the likely impact of this on the frog species? 1 mark

- c. Nominate and describe **one** primary threat to biodiversity that could account for the rapid decline in the population of these frogs in the wild over the last 30 years. 2 marks

- d. Describe a strategy for maintaining and growing the population of these frogs in the wild by addressing the threat nominated in **part c.** 2 marks

DO NOT WRITE IN THIS AREA

Question 3 (10 marks)

The population of an inland city is increasingly experiencing water shortages. The small river that feeds the city’s water storage dam can no longer supply enough water, especially in periods of drought. Farmers downstream from the dam are upset that less water is being made available to them as the city continues to grow. The river also feeds a wetland habitat further downstream that has been harmed by decreasing water flows. The city’s population is predicted to continue to grow significantly over the next 20 years.

Planners have decided that one option to provide more water for human consumption is to treat and recycle the city’s effluent (sewage and wastewater). This purified water would then be added back into the storage dam. The energy required to run the purification system and pumping plant would be sourced from a newly constructed wind farm.

- a. Using the sustainability principles of intragenerational equity and efficiency of resource use, as well as arguments relating to the hydrosphere, explain why this plan should be regarded as an ecologically sustainable development.

6 marks

DO NOT WRITE IN THIS AREA

- b. Explain why monitoring and assessing water quality would be an important part of management planning if this recycled water were to be used for human consumption.

2 marks

- c. Describe a role the media could play in influencing the decision-making process involved in the plan to treat effluent and recycle it as drinking water.

2 marks

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 4 (13 marks)

A new fishing and processing industry, including a new large town that is anticipated to ultimately grow to 70 000 people, is being established on an isolated island. There is a significant turtle habitat on the southern side of the island.

Engineers are considering the best ways to provide electricity for the new town. The island is in a very windy location and has substantial gas reserves just offshore.

The engineers consider three energy supply systems, which may be used in combination:

1. a gas-fired thermal power station – comprising a gas boiler feeding a steam turbine that is driving a generator
2. wind turbines
3. a series of eight large diesel generators

a. Describe **one** advantage and **one** disadvantage of each energy supply system for this location. 6 marks

• Gas-fired thermal power station _____

• Wind turbines _____

• Diesel generators _____

DO NOT WRITE IN THIS AREA

- b. For the gas-fired thermal power station, state each of the energy conversions involved in the process of producing electricity from offshore gas.

2 marks

- c. Considering the engineers' three options, outline the most suitable energy plan to provide for the energy needs of the new town. Give reasons for your energy plan.

3 marks

- d. Explain how the principle of conservation of biodiversity and ecological integrity should be applied to the energy plan you have outlined for the new town.

2 marks

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 5 (9 marks)

A group of engineers is studying ways to improve the energy efficiency of coal-fired, electricity-generating power stations.

- a. Explain the meaning of the scientific term ‘energy efficiency’. 2 marks

- b. Explain how the first law of thermodynamics relates to energy efficiency. 2 marks

- c. One of the engineers says that sustainability refers only to the effect on the environment. A second engineer says that the concept of sustainability should include other aspects.

- i. Which of the two viewpoints is correct? Explain your answer. 2 marks

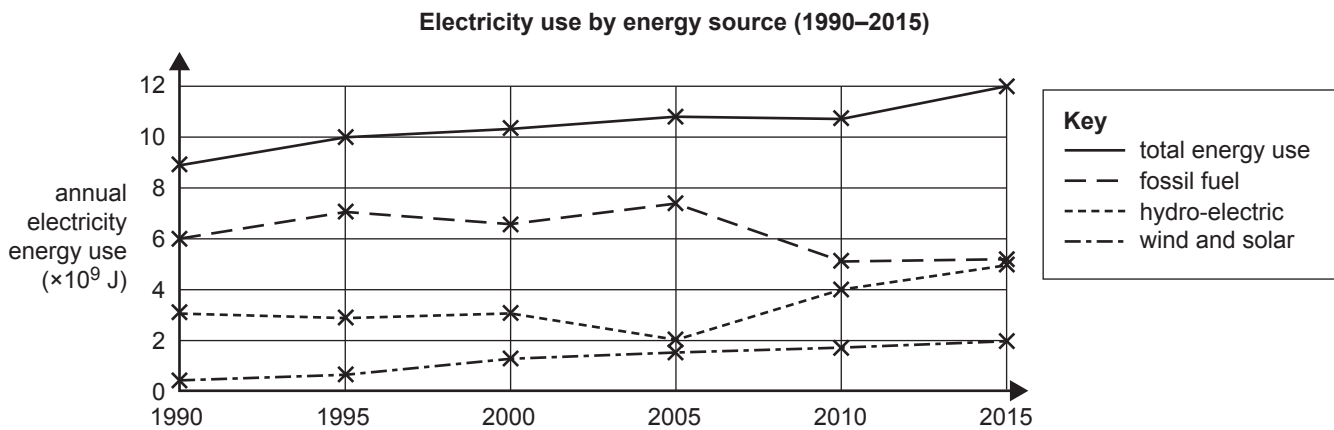
- ii. Suggest how increasing the efficiency of a coal-fired, electricity-generating power station exemplifies the concept of sustainability. 3 marks

DO NOT WRITE IN THIS AREA

Question 6 (6 marks)

An island has several towns. All the electricity is generated on the island.

The sources of energy and annual energy usage are shown in the graph below. Use the data in the graph to answer the following questions.



- a. Calculate the percentage increase in total energy usage between 1995 and 2015. 2 marks

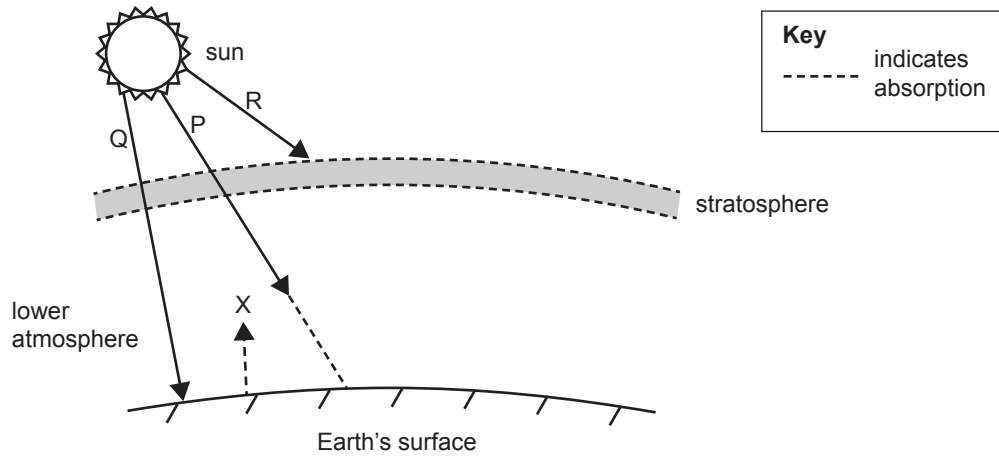
- b. Calculate the percentage of energy obtained from renewable sources in 2015. 2 marks

- c. Based on the information shown in the graph above, give **one** possible reason for the increase in fossil fuel usage in 2005. 2 marks

DO NOT WRITE IN THIS AREA

Question 7 (13 marks)

The following diagram shows different forms of radiation (P, Q, R and X) passing through Earth's atmosphere and interacting with the surface.



a. Name the form of radiation marked 'Q' on the diagram above and indicate its source. 2 marks

b. Describe the interactions that the radiation marked 'Q' has with the atmosphere and Earth's surface, and any energy transformations that occur. 3 marks

c. Name the form of radiation marked 'P' on the diagram above. 1 mark

d. Name the form of radiation marked 'X' on the diagram above and describe its source. 2 marks

DO NOT WRITE IN THIS AREA

- e. Leon states that humans have no effect on climate as the temperature rise experienced at Earth's surface over the past 100 years is natural and, throughout history, the temperature has risen and fallen.

Explain **one** piece of scientific evidence that contradicts Leon's claim.

2 marks

- f. Describe **two** methods that have been used to collect scientific evidence of past atmospheric and climate conditions.

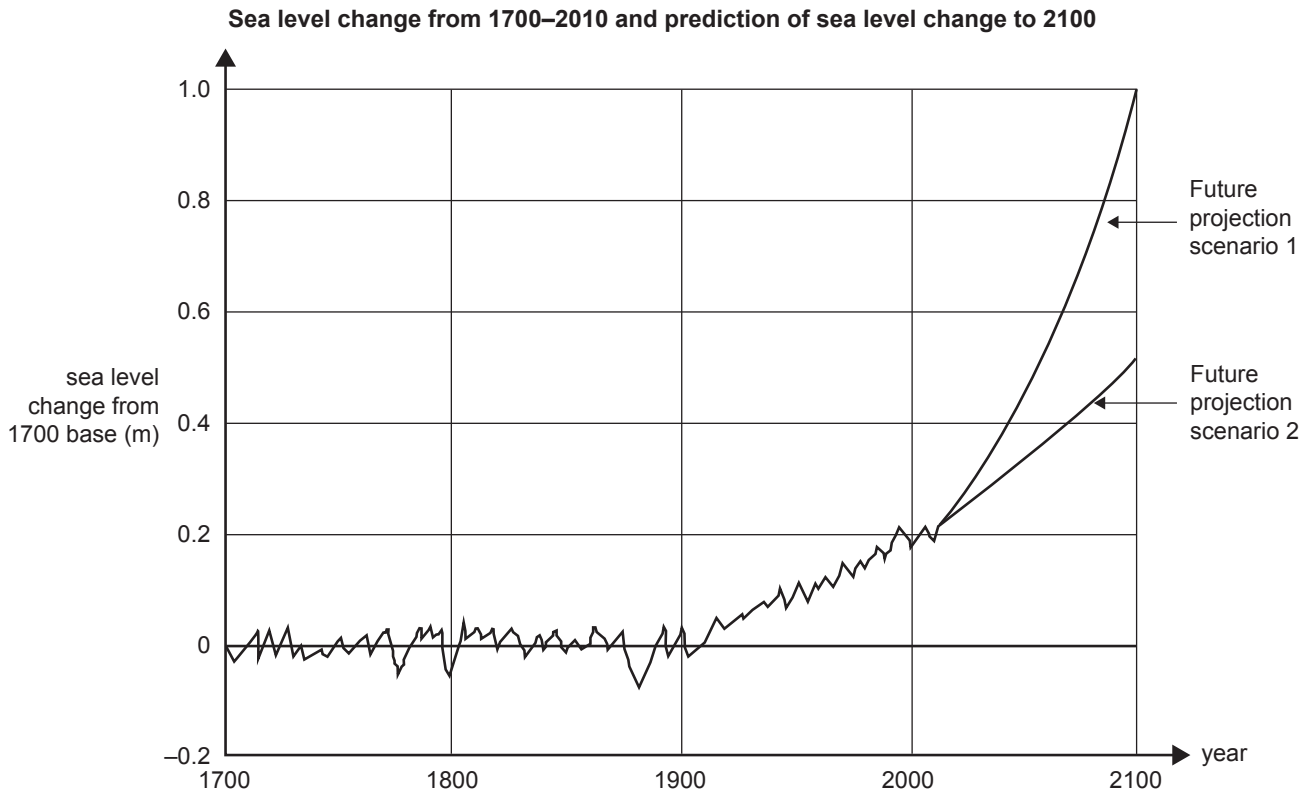
3 marks

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 8 (8 marks)

The graph below shows variations in sea level at a particular location from the year 1700 to the present. Scientists' projections of future sea level rise are represented by two lines, the higher line showing sea level projections under very high greenhouse gas emissions (Future projection scenario 1) and the lower line showing sea level projections under very low greenhouse gas emissions (Future projection scenario 2).



Source: adapted from JA Church et al., '2013: Sea Level Change', in TF Stocker et al. (eds), *Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, 2013, pp. 1137–1216; reproduced with permission of Cambridge University Press

- a. Based on atmospheric conditions, explain why the global sea level showed little change from the year 1700 to 1800. 2 marks

- b. Calculate the approximate change in sea level from 1800 to 2000 (in metres). 1 mark

DO NOT WRITE IN THIS AREA

c. State **two** reasons for the increase in sea level from 1900 to the present.

2 marks

d. With regard to sea level rise, describe **two** actions in future planning that would be required in response to the projected data.

3 marks

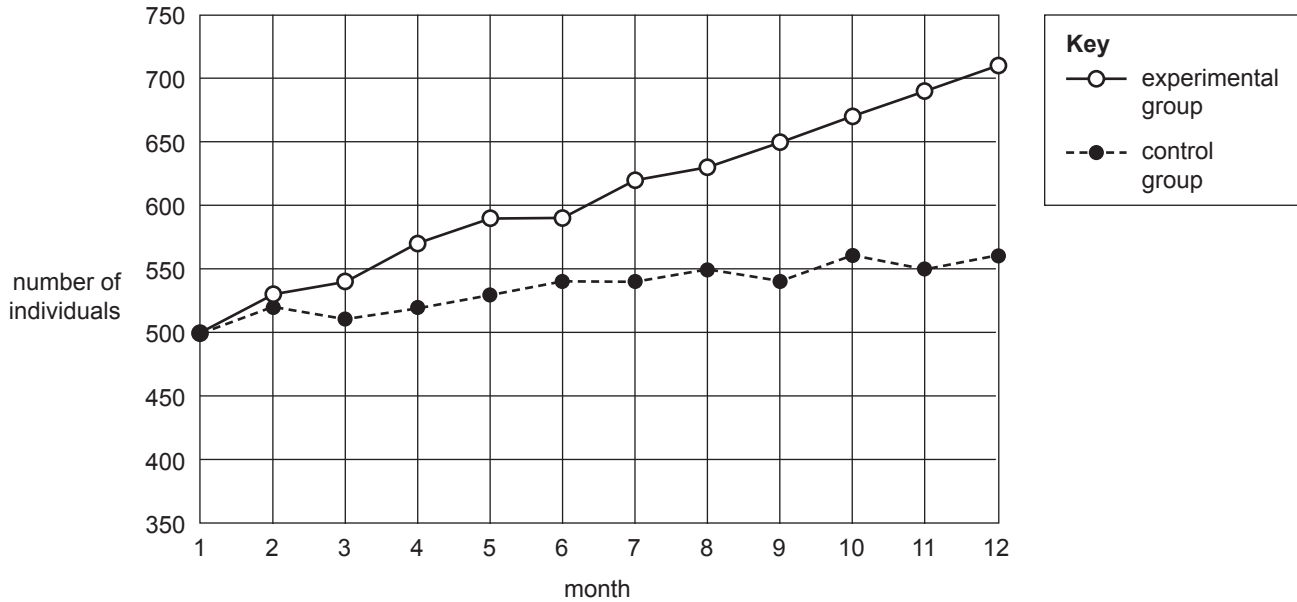
DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 9 (14 marks)

An endangered butterfly species is endemic to a region near a school. The butterfly is found only in four separate areas of remnant vegetation. Each area is around the same size and contains 250 breeding individuals. VCE Environmental Science students, with the help of local environmental groups, conducted an experiment where, at the beginning of Month 1, they joined two of the areas using a wildlife corridor. The sum of the two joined populations was called the experimental group. The sum of the other two, still separate, groups was called the control group. All areas were protected from habitat degradation. Population data for each group was sampled monthly over a period of one year and is summarised in the graph below.

Population numbers of a particular endangered butterfly species over time



a. State the following variables in the experiment. 2 marks

- Independent variable _____
- Dependent variable _____

b. Write a suitable hypothesis that links the independent variable and the dependent variable. 2 marks

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

- c. State **one** important controlled variable in this experiment and explain how this variable improves the validity of the experiment. Make the meaning of the term 'validity' clear in your answer. 3 marks

- d. Based on the data shown in the graph, write a conclusion for this experiment. 2 marks

- e. Give **two** reasons related to biodiversity concepts that could explain the trend in the population data shown in the graph. 3 marks

f. A factor that may have affected the results of this experiment is genetic swamping.

Which group – the experimental group or the control group – could have potentially experienced genetic swamping and why?

2 marks

DO NOT WRITE IN THIS AREA