VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2023

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER | | | | | | | | | Letter |

ENVIRONMENTAL SCIENCE

Written examination

Friday 10 November 2023

Reading time: 11.45 am to 12.00 noon (15 minutes)
Writing time: 12.00 noon to 2.00 pm (2 hours)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	30	30	30
B	8	8	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 31 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.

Question 1

Bioaccumulation and biomagnification represent threats to present-day species.

What is the difference between these two terms?

A. Bioaccumulation is more dangerous to species than biomagnification.

B. Bioaccumulation occurs only in shellfish whereas biomagnification occurs only in predators.

C. Bioaccumulation involves nutrients increasing in concentration in an environment whereas biomagnification is the increase in toxins.

D. Bioaccumulation occurs in the bodies of organisms in one level of the food chain whereas biomagnification increases in higher levels of the food chain.

Question 2

Which one of the following is an example of a biological process used in the rehabilitation of a mine site?

A. Treating wastewater and using it for agriculture.

B. Introduction of hollow logs and nesting boxes for introduced species.

C. Spreading of native seeds at intervals to encourage habitat restoration.

D. Establishing recreational facilities to encourage people to visit the area.

Question 3

The rapid loss of species we are seeing today is estimated by experts to be between 1000 and 10 000 times higher than the background extinction rate.

What is meant by ‘background extinction rate’?

A. The rate of species extinctions that are not recorded by humans.

B. The rate of species extinctions that would occur without anthropogenic factors.

C. The number of extinct species per total number of species during the first mass extinction.

D. The number of species extinctions per total number of species before the industrial revolution.

Use the following information to answer Questions 4–7.

On 6 July 2019, the Budj Bim Cultural Landscape in south-west Victoria was included on the World Heritage List. This area has been described as the 'world's first engineering project' as, from at least 6600 years ago, the Gunditjmara people created an extensive and complex aquaculture network. In this network, modified channels diverted water as well as kooyang (a short-finned eel, *Anguilla australis*) into holding ponds. The eels were then farmed and harvested for food (aquaculture) in a sustainable manner, and maintained at high population numbers. Today, the short-finned eel has been classified as 'near threatened' by the IUCN.

Question 4

The World Heritage Listing of the Budj Bim would have resulted in

A. a change of ownership rights.

B. prevention of any tourism in the area.

C. a national responsibility to conserve the area.

D. changes to the current use of the landscape.

Question 5

The Budj Bim landscape was traditionally a source of cultural and provisioning services to the Gunditjmara people.

Which one of the following pairs of reasons best explains why the landscape was a source of these types of services?

A. a sense of place; and the eels were a food source

B. the aesthetic value; and control of disease

C. a recreational benefit; and the water was purified

D. soil formation; and fuel was provided for burning

Question 6

What does the conservation category of 'near threatened' indicate for the short-finned eel *Anguilla australis*?

A. It is of least concern.

B. It will become endangered in the near future.

C. It could be classed as vulnerable if population numbers reduce.

D. It will be extinct soon if conservation strategies are not put in place.

Question 7

It is important to maintain or increase population numbers in 'near threatened' species like the eel because this

A. maintains genetic diversity.

B. reduces ecosystem diversity.

C. increases the pace of evolution.

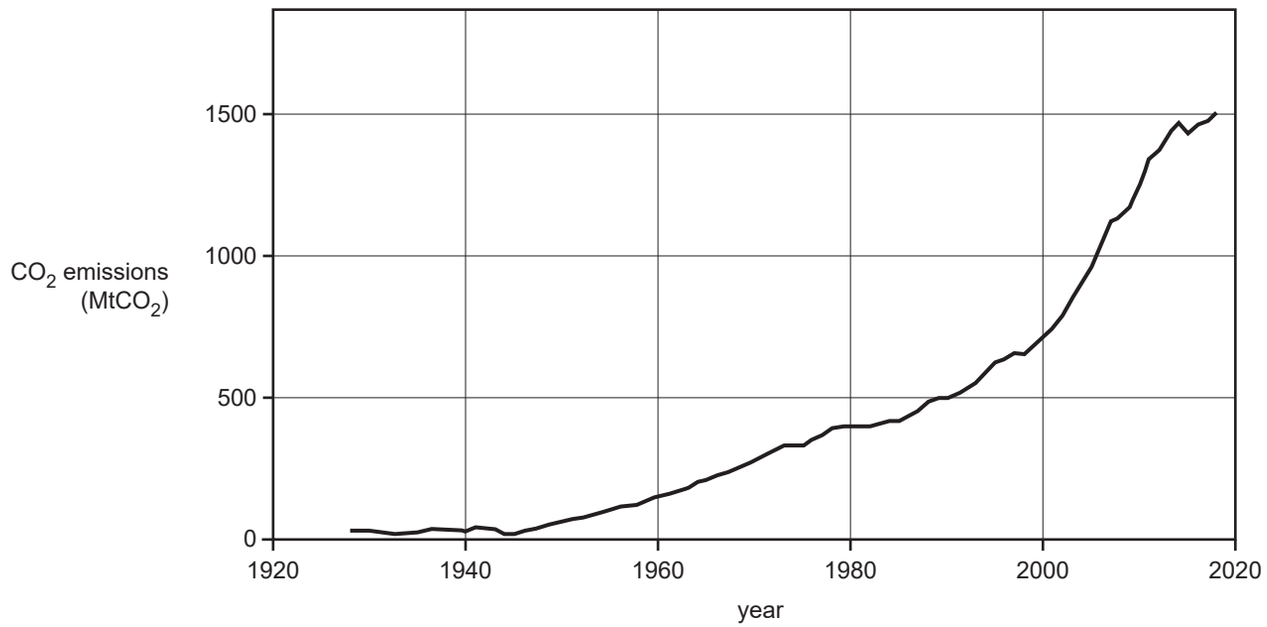
D. increases inbreeding between populations.

Use the following information to answer Questions 8 and 9.

Cement is a construction material used globally. The production and use of cement contributes to more than 7% of global anthropogenic greenhouse gas emissions. At present there is no suitable substitute material.

The graph below shows global historic trends of carbon dioxide emissions from cement production.

Global emissions of carbon dioxide from cement production, 1928–2018



Source: adapted from Andrew, R. M., 'Global CO2 emissions from cement production', 1928–2018, Earth Syst. Sci. Data, 11, 1675–1710; https://doi.org/10.5194/essd-11-1675-2019, 2019. licensed CC-BY 4.0 [https://creativecommons.org/licenses/by/4.0/]

Question 8

Why was there a steep increase in carbon dioxide emissions after the end of World War II in 1945?

A. It was the time of the industrial revolution.

B. Cement was used globally for the first time.

C. Cement became a highly used building material following World War II.

D. The manufacturing process changed and carbon dioxide emissions were significantly higher.

Question 9

Apart from cement production, other global anthropogenic sources of greenhouse gas emissions include

A. land clearing and rice farming.

B. volcanic eruptions and plant respiration.

C. solar variability and wildfires.

D. use of biofuel and forest regrowth.

DO NOT WRITE IN THIS AREA

Question 10

Why does carbon dioxide have a greenhouse gas warming potential of 1?

A. It quantifies the amount of energy it absorbs and stores.

B. It provides a rating for the amount of solar energy reflected.

C. It absorbs more infrared radiation than 1 tonne of water vapour.

D. It is being used as a reference to compare with other greenhouse gas warming potentials.

Question 11

Ice cores are extracted via drilling through ice sheets and can provide information on historical climatic conditions.

Ice core samples can primarily be used to determine past air temperatures by analysing the

A. percentage of pollen in the ice core.

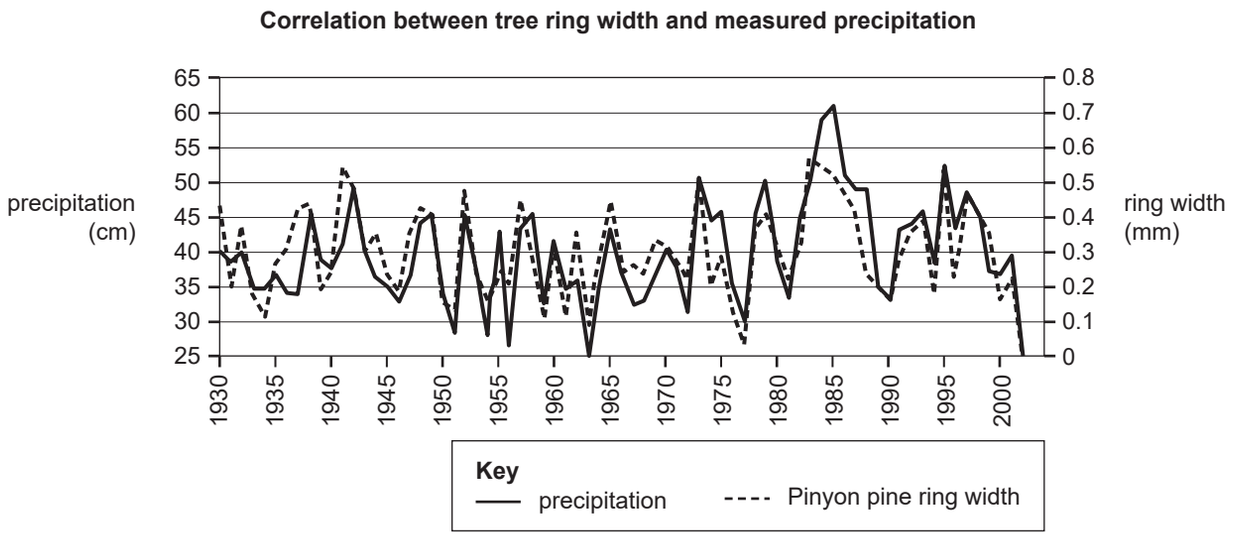
B. thickness of the annual layers in the ice core.

C. density of sea salt in the centre of each layer.

D. ratio of oxygen or hydrogen isotopes in different layers.

Question 12

Scientists were investigating the correlation between precipitation and tree ring width for the Pinyon pine tree to assist with understanding streamflow in the study area. Data recorded is presented in the graph below:



Source: Connie Woodhouse, 'Part 3 - Understanding Long-term Streamflow Using Tree-Ring Science' , https://serc.carleton.edu/trex/students/labs/lab4_4.html, TREX Tree Ring Expeditions (website); graph licensed CC-BY-NC-SA [http://creativecommons.org/licenses/by-nc-sa/3.0/]

What can be concluded from the information in the graph between 1980 and 1990?

A. Tree ring width was lowest in the year 1985.

B. Tree ring width always increases as precipitation increases.

C. Precipitation is not the only variable that affects ring width.

D. There is no relationship between precipitation and ring width.

Question 13

There are a number of interactions involving solar energy that contribute to the natural greenhouse effect.

In the natural greenhouse effect, visible light is

A. reflected by Earth as infrared radiation.

B. reflected by greenhouse gases as visible light.

C. absorbed by ozone and re-emitted as ultraviolet light.

D. absorbed by Earth and re-emitted as infrared radiation.

Question 14

The albedo effect has a significant effect on Earth's climate. Surfaces on Earth are provided with an albedo score that ranges from 0–1, which is based upon the reflectivity of the surface.

Which one of the following statements is true regarding the albedo effect?

A. Sea water has a lower albedo score than sea ice.

B. A surface with 100% reflectivity would have an albedo score of 0.

C. The lower the albedo score of Earth, the cooler the temperatures on Earth will be.

D. The higher the albedo score of a surface, the more radiation will be absorbed by the surface.

Question 15

Climate models are used to make projections about future climate patterns.

It is correctly argued that they have limitations due to

A. climate data used to drive the mathematical equations being often contradictory.

B. the lack of strong evidence to support the theory that climate change is caused by the enhanced greenhouse effect.

C. computer systems not being powerful enough to process available data and simulate the complexities of the actual global climate.

D. considering only atmospheric climate patterns that are occurring, but not other variables related to ocean and land cover changes.

Question 16

In 2015, a large tailings dam failed at an iron ore mine in Brazil. Fifty million tons of mud and toxic waste poured into a major river. The mining waste polluted the river and devastated fish populations, as well as making the water unsuitable for drinking.

This event would have had harmful impacts on the

A. biosphere and lithosphere.

B. hydrosphere and biosphere.

C. lithosphere and atmosphere.

D. hydrosphere and lithosphere.

Question 17

Concerns about overfishing by Australian fishing industries grew in the 1990s. Fisheries management was hindered by poor information about fish levels and a lack of specific understanding of the marine environment and long-term impacts from fishing. The government changed international fisheries agreements and Australian legislation in order to limit the impacts of commercial fishing, in an effort to make these resources sustainable.

This information suggests that the changes were made because

A. the Australian fishing industry was concerned about competition from international fishing companies.

B. environmentalists and other key stakeholders were demanding more protection for the marine environment.

C. the government was certain that the Australian fishing industry was in economic trouble and would be unsustainable if no changes were made.

D. the lack of relevant scientific knowledge, combined with a potential for serious and/or irreversible environmental damage, suggested that precaution was warranted.

Question 18

What is the best explanation of the sustainability principle of 'conservation of biodiversity and ecological integrity'?

A. All species and their ecosystems should be protected and conserved for future generations.

B. Every important threatened species and their ecosystems should be conserved and protected for the use of current generations.

C. The diversity of species, including genetic diversity, should be maintained at current levels, while protecting life-supporting ecosystems.

D. The variety of species (including genetic diversity) should be maintained, with the quality of ecosystems and their capacity to provide for the needs of future generations enhanced.

Question 19

A group of students wanted to research the population size of southern water skinks (a small lizard native to southern Australia) at a small remnant bushland site located next to a river. They set traps throughout the bushland and on the first visit trapped, marked and released a total of 32 skinks. They returned two weeks later and reset the traps and this time caught 52 skinks, of which 16 were marked.

What is the estimated population size of southern water skinks in the bushland site?

A. 84

B. 100

C. 104

D. 266

Question 20

Which one of the following contains only renewable energy sources?

A. biomass, hydro-electricity, tidal, wind electricity

B. solar hot water, biofuels/biogas, natural gas, biomass

C. hydro-electricity, wind electricity, natural gas, crude oil

D. coal seam gas, solar electricity, biofuels/biogas, brown coal

Question 21

Australian energy consumption by fuel type 2020–2021

Energy source	Final energy consumption (petajoules)
Crude oil	2098
Natural gas and coal seam gas	1568
Black and brown coal	1661
Renewables	462
Total	5789

Source: https://www.energy.gov.au/energy-data/australian-energy-statistics/data-charts/australian-energy-consumption-fuel-type

Many thermal power stations currently use black and brown coal to produce electricity. The average energy efficiency of these power stations is 30%.

How much potential energy was required as an input to produce the final energy consumption from black and brown coal in 2020–2021?

A. 498 petajoules

B. 3876 petajoules

C. 5537 petajoules

D. 7450 petajoules

Question 22

Solar generation increased by 42% in the 2019–20 financial year. This was mostly a result of increased solar photovoltaic panel installation.

Which one of the following is an example of how solar photovoltaic panels can be used to decrease energy used from fossil fuel sources?

A. decreasing a home's total energy use

B. powering an electric cooktop, rather than a gas-burning stove

C. heating outdoor swimming pools that were previously unheated

D. powering electric heating instead of using a wood-burning heater

Question 23

How does the generation of electricity from wind energy relate to the first law of thermodynamics?

A. Energy available for producing electricity is lost as waste heat.

B. The amount of useable electricity produced is less than the energy put into the system.

C. Wind energy is not created, it is the product of solar energy converted into kinetic energy.

D. As the wind turbine spins, not all wind is used, leading to inefficient energy conversion.

DO NOT WRITE IN THIS AREA

Question 24

Many homes in Australia, particularly older homes, are poorly insulated.

Why is installing insulation seen as a method of decreasing personal energy consumption?

A. Well-insulated homes require less energy for temperature control.

B. Well-insulated homes cost less to heat and cool, saving the homeowner money.

C. Insulation helps to generate energy inside the home in winter, keeping it warmer.

D. During summer, insulated homes keep warm air inside the home, increasing energy used for cooling.

Question 25

Which one of the following best describes the concept of peak oil?

A. the highest year of total energy production

B. the highest rate of energy produced from oil in a 24-hour period

C. the total amount of oil that can be extracted from Earth's resources

D. the point in time when oil production is highest, before steadily decreasing

Use the following information to answer Questions 26–30.

An Environmental Science class investigated the water quality of a local lake. They collected a water sample while on a boat and took it back to the laboratory for testing. The class repeated the three tests five times, using the same techniques and equipment. The class results were compared to values determined by correctly calibrated, standardised equipment using the same water sample. Their results are shown in the table below.

Lake water test results

	Class results 1	**Class results 2**	**Class results 3**	**Class results 4**	**Class results 5**	**Standardised equipment results**
Dissolved oxygen (mg/L)	8.6	8.7	8.6	8.7	8.8	8.6
Nitrates (mg/L)	76	74	74	75	73	74
Total dissolved solids (mg/L)	622	628	625	629	626	685

Question 26

Which one of the following statements is correct for the data collected by the students?

A. These results do not demonstrate repeatability.

B. The fifth set of results is the most accurate overall.

C. The total dissolved solids results are less accurate than the nitrates results.

D. The total dissolved solids results are more accurate than the dissolved oxygen results.

Question 27

The teacher suggested that the results obtained by the students demonstrated precision.

This is because

A. the result values agree closely with each other.

B. no errors were found in the results or the methods used to determine these levels.

C. all the results have been calculated using the same techniques and equipment, and using the same water sample.

D. these results measure what the students were supposed to be measuring (i.e. dissolved oxygen, concentration of nitrates and total dissolved solids in the lake).

DO NOT WRITE IN THIS AREA

Question 28

Another group of students decided to test the same water quality parameters in the lake but recorded the nitrates concentration as 76 ± 3 mg/L and total dissolved solids as 686 ± 5 mg/L.

Why did these students record the measurements differently by using the addition of the ± figures?

A. Because mg/L is the correct unit of measurement for nitrates and total dissolved solids levels in water.

B. To represent the 'uncertainty' in the measurements and to indicate the ranges of values in which the true values were expected to lie.

C. To identify and eliminate every possible outlier, which are readings that lie a long way from all the other collected results.

D. To eliminate any systematic errors that may have caused readings to differ from the true value by a consistent amount each time a measurement was made.

Question 29

Why did the first group of students wear life jackets while they were in the boat to collect the water sample?

A. to follow health guidelines

B. to follow safety guidelines

C. to follow ethical guidelines

D. to follow accepted scientific methodology

Question 30

The data generated by the first group of students would be regarded as

A. primary data that is qualitative.

B. primary data that was collected firsthand.

C. secondary data that uses professional data to authenticate the students' results.

D. secondary data using techniques determined to be appropriate by the teacher and other scientists.

END OF SECTION A
TURN OVER

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided.

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

Question 1 (12 marks)

The Kurranji Babu is a 28-hectare lot of land that borders the Daintree Rainforest. Formerly a palm oil plantation, by 2010 the area's ecosystems had been significantly disrupted by clearing, but still included some patches of remnant vegetation. After 2010, the Kurranji Babu became an example of a successful restoration project. Between 2010 and 2014, owners and environmentalists worked to restore the vegetation of the area. A number of quantitative measures have been used to indicate the success of the restoration efforts. There was an increase in native vegetation coverage from around 19 hectares in 2010 to around 27 hectares by 2019. Simpson's Index of Diversity (SID) also increased after restoration. SID was measured before and after restoration using large representative quadrats, with consideration of edge effects.

a. What measurements would need to be taken from the quadrats to enable SID to be calculated? 2 marks

b. The formula for SID is shown below:

$$\text{SID} = 1 - \frac{\sum\left[n_i(n_i - 1)\right]}{N(N-1)}$$

What does 'N' represent in the formula? 1 mark

c. If the value of 'N' is higher in one sampling area due to the domination of one species, will the value of SID be higher, lower or the same? Circle your choice below. 1 mark

Higher Lower Same

DO NOT WRITE IN THIS AREA

d. Explain how edge effects reduce accuracy and how this may have been considered in the quadrat sampling. Include definitions of the terms 'edge effects' and 'accuracy' in your answer. 4 marks

e. The percentage coverage of vegetation is also a good measure of the biodiversity of an area. In Kurranji Babu this increased from around 19 hectares in 2010 to around 27 hectares by 2019.

Calculate the percentage increase in plant coverage after restoration efforts. Show your working. 2 marks

f. Explain one plant restoration strategy that environmentalists may have used in the area. 2 marks

Question 2 (9 marks)

The eastern pebble-mound mouse (*Pseudomys patrius*) is one of four species of tiny Australian native mice that construct mounds of pebbles comprising conical, volcano-like ramparts built around burrow entrances. Although each mouse weighs only 10–19 grams, the pebble mounds can be large, weighing more than 50 kilograms and encompassing 10 square metres.

Source: Anders Zimny, <flickr.com>

Mounds are a critical part of the habitat for eastern pebble-mound mice because females raise their litters in the mounds and their female offspring tend to disperse only as far as the next available mound to reproduce. Habitat fragmentation, where the destruction of suitable habitat leaves populations isolated, is a threat to the mice. The erosion of hills and vegetation and the spread of sandy areas in arid Australia is reducing the distribution of the mice.

a. Explain why this species is at particular risk as a consequence of habitat fragmentation, considering the behaviour of the females. 3 marks

DO NOT WRITE IN THIS AREA

b. To identify species in need of conservation action, scientists may undertake an assessment of conservation status.

Describe one qualitative assessment indicator that would be used to provide evidence for a greater need to conserve the pebble-mound mouse. 2 marks

c. Suggest two management strategies, other than captive breeding, that could be used to reduce the risk of extinction of the pebble-mound mouse. In your answer, outline why each strategy could be successful in countering the threats to particular species.

Management strategy 1 2 marks

Management strategy 2 2 marks

Question 3 (12 marks)

The 'Ranch and Billabong' is a 5-hectare site to the west of Dimboola, a town in north-west Victoria. The site is managed by the Barengi Gadjin Land Council (BGLC), which represents the traditional owners and custodians, collectively known as the Wotjobaluk peoples. In addition to holding native title, the Wotjobaluk peoples have maintained a close connection to the Barringgi Gadyin lands, which include the Wimmera River.

Another key stakeholder is the Wimmera Catchment Management Authority (WCMA). The role of the WCMA is to care for the health of the land, rivers and water resources in this catchment region, and to promote sustainable and productive land use practices. The competing demands for water include domestic water supply for townships, water for irrigation, water for grazing animals, and water for recreational uses, such as boating and fishing.

Changes to a road between the Ranch and Billabong site and the Wimmera River cut the billabong off from its regular water source in 2000. This led to a deterioration in the environmental quality of the site over a number of years. Key species such as the river red gum were showing signs of stress, water quality was poor and there was a lack of aquatic plants that provide habitat for fish and insects.

A management plan was created in 2005 for the site, with the aim of restoring flora and fauna habitat and controlling weed invasion. The plan also included developing indigenous signage, information, and educational opportunities to share the culture of the traditional owners. As part of the management plan, water allocations have been pumped into the billabong to help return it to a more natural flooding regime.

Monitoring before and after water allocations were delivered showed that salinity levels in the billabong halved, with frog and waterbird species quickly returning to the habitat. These water allocations by the WCMA began in 2018 and were repeated in 2019, 2020 and 2021.

a. Describe how environmental water allocations should be sourced from the Wimmera River and directed to the billabong in a manner that meets the sustainability principles of 'efficiency of resource use' and 'intergenerational equity'. Make clear the meaning of the two principles in the context of this example in your answer. 3 marks

DO NOT WRITE IN THIS AREA

b. Describe how the management plan considers the relationship between the ecological and sociocultural dimensions of sustainable development. 3 marks

c. A cost-benefit analysis of the use of the water resources for environmental watering of the billabong would also include an evaluation of economic factors.

Using the spaces in the table below, identify two costs and two benefits. 4 marks

Economic factors	
Costs	**Benefits**

d. Why have the knowledge and priorities of the traditional owners, the Wotjobaluk peoples, been valued as part of the decision-making process for managing this site? 2 marks

Question 4 (8 marks)

A coastal town in south-west Victoria is being affected by the impacts of climate change, particularly sea level rise and erosion. Scientists have predicted sea level rise of at least 80 cm by 2100 and wave surges during extreme storms to increase in height by 10–15%. The erosion caused by this is having a significant impact on the local area, including the hollowing of dunes, erosion of land close to roads and homes, and destruction of coastal features.

The local council is planning to build a seawall to protect infrastructure and residential areas against the erosion. Environmentalists argue that the seawall will result in habitat loss for many native species, and may actually accelerate erosion along the coast.

a. Explain how climate change has caused sea levels to rise. 2 marks

b. A part of the council's action plan is to regularly collect sea level data.

Describe how this collected sea level data can be used to assist management. 2 marks

c. Climate projections state that over the next 10 years this coastal area will have a very high chance of more frequent and intense extreme precipitation events.

Describe how climate projections are determined. 2 marks

DO NOT WRITE IN THIS AREA

d. Identify one priority for the local council, and one priority for the local environmental group in addressing the impacts of the rising sea levels. 2 marks

Local council _____

_____

Local environmental group _____

_____

DO NOT WRITE IN THIS AREA

Question 5 (12 marks)

a. State the importance of the natural greenhouse effect to life on Earth. 1 mark

Atmospheric greenhouse gas concentrations have altered since the industrial revolution, which has led to an enhanced greenhouse effect.

b. **i.** Complete the table below by stating if the concentration of each listed greenhouse gas has changed over time or not (increased, decreased or stayed the same) and by explaining the cause, if any, of this change. 4 marks

Greenhouse gas	Change over time (increased/ decreased/stayed the same)	Explanation
Water vapour		
Carbon dioxide		

ii. Explain how the change in concentration of carbon dioxide affects the average global temperature on Earth. 2 marks

DO NOT WRITE IN THIS AREA

To reduce the impacts of the enhanced greenhouse effect, a state government has the aim of reducing net carbon dioxide emissions to zero by 2050. One way the government intends to meet this target is through the use of forestry. Two options are being considered:

Option one: Growing plantation forests via afforestation (planting trees where they have not historically grown).

Option two: Maintaining an existing forest, which is thousands of years old, and protecting it from proposed land clearing for a housing development.

c. Considering the carbon cycle, state whether afforestation (option one) or protection of existing forests (option two) would be more effective in meeting the government's aim. Justify your decision. 3 marks

d. Other than the use of forests, identify **two** technologies used to reduce atmospheric carbon dioxide levels. 2 marks

Question 6 (12 marks)

Bioethanol is a biofuel. Bioethanol can be blended with petrol for use in vehicles. E10 petrol includes 10% bioethanol and is widely available in Australia.

Recently, buses have been designed to run on higher percentages of bioethanol produced from locally grown sugarcane waste. The buses can utilise a 95% bioethanol blend (E95 petrol), much higher than the blended fuels currently available for consumer use.

Source: ABC News, https://www.abc.net.au/news/2022-04-13/electric-buses-rolled-out-queensland-environment/100984570; ADD Image © Translink, reproduced with permission

a. Complete the following table by circling the correct description for each fuel type. 2 marks

Biofuel	Fossil fuel/Non-fossil fuel	Renewable/Non-renewable
Petrol	Fossil fuel/Non-fossil fuel	Renewable/Non-renewable

DO NOT WRITE IN THIS AREA

b. Describe the impact of the production and use of bioethanol on the carbon cycle. 3 marks

c. Explain how the use of bioethanol can be seen as 'circular economy thinking' in action. 2 marks

d. A similar project has been proposed that would convert waste from hardwood sawmills into biodiesel. This fuel would then be used to power trucks transporting timber products.

Compare the environmental impacts of accessing and extracting conventional diesel to producing biodiesel. 3 marks

e. The adoption and investment in biofuels aligns with the ethical value system of technocentrism.

Explain this alignment, making the meaning of 'technocentrism' clear in your response. 2 marks

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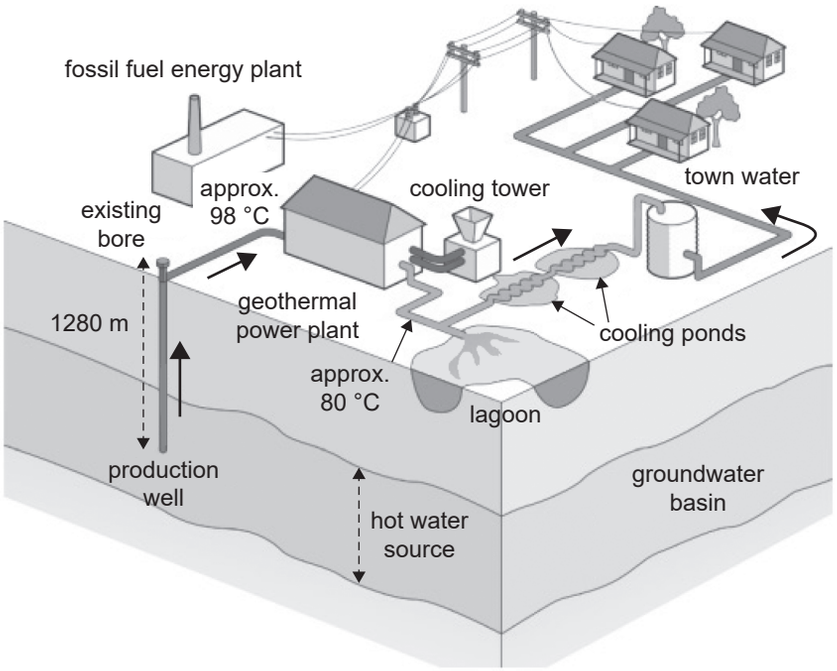
Question 7 (10 marks)

Geothermal energy is heat from the earth that is brought to the surface using steam or water. The energy can be converted into electricity at a power station.



Source: adapted from Dr Cameron Huddlestone-Holmes, *Geothermal Energy in Australia*; CSIRO, 2014, <arena.gov.au>; Figure 9 Schematic of the Birdsville Geothermal Power Station; modified from Ergon Energy Birdsville Organic Rankine Cycle Geothermal Power Station fact sheet (Ergon Energy, 2013)

a. Identify the form of energy present at each stage of geothermal energy production. 2 marks

Earth's core	→	Steam	→	Turbine	→	Generator

DO NOT WRITE IN THIS AREA

b. Explain why the amount of energy that leaves the geothermal power plant is greater than the amount that reaches homes for use. 2 marks

c. Explain why geothermal energy could be used to supply base load energy. 2 marks

d. The work required to access geothermal energy can have implications for the sustainability principle of 'intragenerational equity'.

Explain how the establishment of a new geothermal power plant can impact intragenerational equity. 2 marks

e. In Victoria, major projects, such as building a geothermal power plant, require consultation with diverse groups of stakeholders.

Identify one group of stakeholders and state why it would be important to engage with this group. Use factors relevant to the geothermal power plant in your response. 2 marks

Question 8 (15 marks)

A group of Environmental Science students observed the increasing negative impacts of rising salinity levels on the growth of eucalypt trees in their local area. To investigate this further, the students obtained 60 eucalypt seedlings, 30 each of species A and species B. These seedlings were all 12 months old and had been raised under identical conditions at a local nursery. The following flow chart summarises the investigation method used by the students.

All 60 seedlings moved into a greenhouse for two weeks.
Each given 80 mL of liquid fertiliser.
Consistent growing conditions in greenhouse:
- 25 °C temperature
- 55% humidity
- Fixed light intensity with a 14 hour day/10 hour night

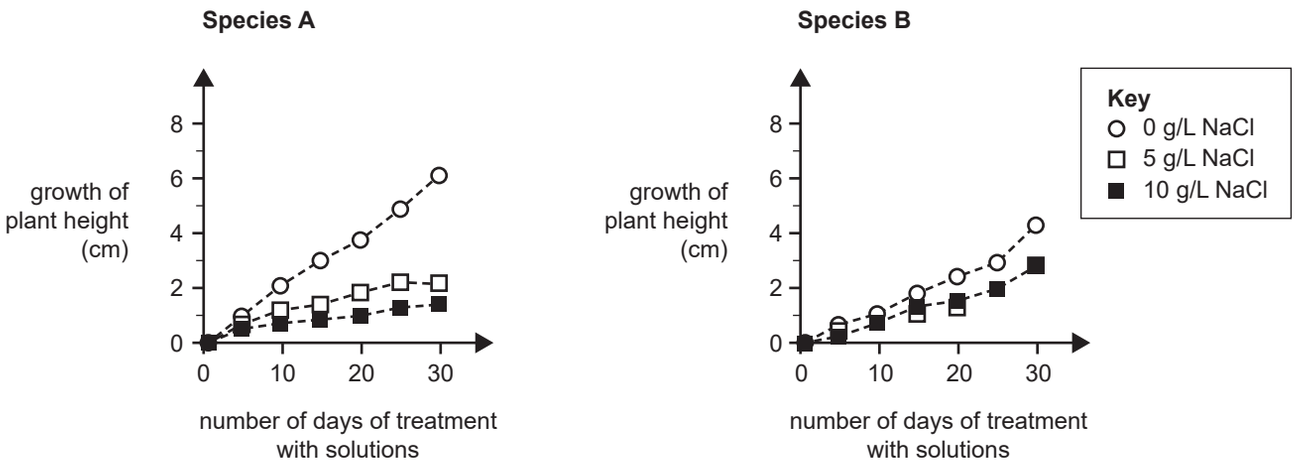
↓

After two weeks, the 30 seedlings from species A and the 30 from species B were divided into three groups (10 plants in each group).
Watered every second day for 30 days with different solutions:
- Group 1 – pure water (0 g/L NaCl)
- Group 2 – 5 g/L NaCl solution
- Group 3 – 10 g/L NaCl solution

↓

Average growth of eucalypt seedlings in each group measured every five days using the same ruler. Results recorded in the following graph.

The amount of growth in two eucalypt species watered with different saline solutions



Source: H Balti, M Abassi, KJ Dietz and V Kumar, 'Differences in Ionic, Enzymatic, and Photosynthetic Features Characterize Distinct Salt Tolerance in Eucalyptus Species', *Plants*, vol. 10, no. 7, 9 July 2021, accessed via MDPI at https://www.mdpi.com/2223-7747/10/7/1401#

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a. Write a suitable hypothesis for the investigation conducted by the students. 2 marks

b. Identify each of the following variables in this investigation. 3 marks

The dependent variable:

The independent variable:

One controlled variable:

c. The ruler used to measure the growth of the seedlings was later found to be incorrectly calibrated, with each centimetre on the ruler actually showing only 9.3 millimetres.

Identify this type of scientific error. 1 mark

d. Once this error was identified, one of the students within the group claimed that the results were no longer valid.

Explain if this student's viewpoint is correct or not, making clear the meaning of the term 'validity'. 2 marks

e. A local farmer heard about the students' experiment and asked them to recommend which of the two eucalypt species she should plant on her property. The farmer has tested the soil in the area and has measured a high level of salinity, equivalent to 9 g/L of NaCl.

Which of the two species do you suggest the students recommend? Justify your answer using data from the graph. 3 marks

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f. The students wanted to test the reproducibility of the farmer's salinity measurements.

Using **two** examples, explain how they could test salinity levels of the soil to confirm the reproducibility of the farmer's results. Make clear the meaning of 'reproducibility'. 4 marks

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END OF QUESTION AND ANSWER BOOK


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