

STUDENT NUMBER: _____ - _____ - _____ - _____

STUDENT NAME _____ CLASS: _____



**SUGGESTED SOLUTIONS
HIGHLIGHTED OR IN RED**

Victorian Certificate of Education 2024 Environmental Science Written Trial Examination

Reading time: 15 minutes

Writing time: 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	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 24 pages
- Answer sheet for multiple-choice questions (Page 25)

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.

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Section A – Multiple Choice

Instructions for Section A

Choose only **one** correct response for each question on the answer sheet provided.
Circle the correct response on your answer sheet. No marks are deducted for an incorrect response.
No marks will be awarded if more than one response is circled.

Question 1

Which category of biodiversity primarily focuses on the variation **within** populations **and among individuals of a species**?

- A. Genetic biodiversity.
- B. Species biodiversity.
- C. Ecosystem biodiversity.
- D. Community biodiversity.

Question 2

Ecosystems are a source of renewable services that impact human health and wellbeing. Which category of ecosystem services is associated with recreational services and a sense of place **for humans**?

- A. Provisioning services.
- B. Regulating services.
- C. Supporting services.
- D. Cultural services.

Question 3

Tectonic plate movement is a natural change that influences biodiversity. How does tectonic plate movement lead to species endemism?

- A. By creating barriers that isolate populations, leading to speciation.
- B. By causing climate change that drives species to adapt rapidly.
- C. By facilitating long-distance dispersal of species across continents.
- D. By regulating volcanic activity that creates new habitats for endemic species.

Question 4

At times in Earth's history, significant mass extinctions have occurred. Which of the following lists the features of a mass extinction?

- A. Isolated event, affects vulnerable species in an area, usually take less than 1 million years.
- B. Widespread event, affects most species alive at the time, occurs gradually over hundreds of millions of years.
- C. Widespread event, affects most species alive at the time, usually take less than 1 million years.
- D. Widespread event, affects most mammal species alive at the time, usually take less than 1 million years.

Use the following information to answer Questions 5–8.

Kakadu National Park in the Northern Territory is a prominent example of a national park in Australia and is also a classified World Heritage site. Kakadu National Park encompasses diverse ecosystems including wetlands, floodplains, and mangrove forests that provide essential habitat for numerous species.

Question 5

Despite having a protected status, Kakadu National Park faces threats to its biodiversity. Which of the following would **not** pose a threat to biodiversity in Kakadu National Park?

- A. Climate change.
- B. Improved targeting of pesticides in agricultural areas.
- C. Loss of pollinators, dispersal agents, host species or symbionts that affect reproduction and persistence of species.
- D. Introduced species that compete for shelter, food, and water.

Question 6

As a strategy for maintaining and growing biodiversity, an advantage of a **protected** areas is:

- A. Protected areas are often isolated islands in a landscape fragmented by human activities such as agriculture, urbanization, and infrastructure development.
- B. Protected areas often cover only a fraction of the Earth's surface and may not represent all ecosystems and biodiversity types equally.
- C. Protected areas benefit from legal and institutional frameworks that provide legal status, management guidelines, and enforcement mechanisms to protect biodiversity effectively.
- D. Protected areas may not be resilient to the impacts of climate change, such as shifting temperature and precipitation patterns, altered fire regimes, and sea-level rise.

Question 7

As a classified **World** Heritage Area, Kakadu National Park would

- A. no longer belong to the people of Australia.
- B. be prevented from hosting tourist activity.
- C. be protected by international agreements.
- D. guarantee no species in the park become extinct.

Question 8

Kakadu National Park provides an example of how protected areas can contribute to the conservation of species like the saltwater crocodile and preserving biodiversity and ecological integrity for **future** generations.

This provides an example of the sustainability principle:

- A. Efficiency of resource use.
- B. Intergenerational equity.
- C. Intragenerational equity.
- D. Precautionary principle.

Question 9

Which principle best represents the requirement that tourists visiting some National Parks and camping sites must have **purchased a permit** in Australia?

- A. Intergenerational equity.
- B. Efficient resource use.
- C. Precautionary principle.
- D. User-pays principle.

Question 10

Which option represents how the Flora and Fauna Guarantee Act 1988 (Vic) protects threatened species?

- A. By restricting land use changes.
- B. Regulation of international trade of the species.
- C. Providing legal protection and management measures to conserve species.
- D. By identifying and assessing species' conservation status.

Question 11

Which option best represents the principle 'Intergenerational equity'?

- A. Upgrading of drainage systems in an urban setting by the local council.
- B. Regulations in the fishing industry that control the timing of fishing, the types of fishing gear and boats, and catch quotas.
- C. Transferring government owned land for the establishment of livestock farming.
- D. Increasing the costs at local landfill sites.

***Option B is correct as these regulations are aimed at maintaining sustainable wild stock; prevents over-fishing that benefits future generations; conserves ecosystems services and productivity.**

Question 12

Which of the challenges to sustainability does the use of farming practices such as crop rotation, mixed crop-livestock methods, and on-site energy production address?

- A. Food.
- B. Energy.
- C. Water.
- D. All the above.

Question 13

Scientists working in the Serengeti National Park, Tanzania, focus their conservation efforts on maintaining the **integrity of the entire** savanna ecosystem, which supports a diverse array of wildlife. This viewpoint is described as:

- A. Ecocentrism.
- B. Anthropocentrism.
- C. Biocentrism.
- D. Technocentrism.

Question 14

A local Landcare group is working on a project to build rock walls, create terracing, and plant native vegetation to help stabilise slopes and prevent sediment runoff into waterways. This is primarily an example of

- A. a conservation covenant.
- B. erosion control.
- C. reintroduction of previously endemic species.
- D. protected areas.

Question 15

The Environment Protection Authority (EPA) conducting audits and compliance checks on the wastewater industry is part of

- A. a regulatory framework system.
- B. deals between industries that produce wastewater.
- C. the User-pays principle.
- D. Stakeholder agreements.

Question 16

The table below lists the global warming potential for the major greenhouse gases over 100 years.

Greenhouse gas	Global warming potential over 100 years
Carbon dioxide	1
Methane	28 – 36
Nitrous oxide	265 – 298
Chlorofluorocarbons	125 – 152
Hydrochlorofluorocarbons	125
Perfluorocarbons	6,500
Sulphur hexafluoride	23,900

Which statement below **is incorrect**?

- A. Among the listed gases, sulphur hexafluoride has the highest global warming potential over a 100-year period.
- B. One methane molecule will warm the Earth more than one nitrous oxide molecule over a 100-year period.
- C. Chlorofluorocarbons and hydrochlorofluorocarbons have global warming potentials within a similar range over a 100-year period.
- D. Carbon dioxide has a global warming potential of 1 in a 1000-year period.

***Option B is correct as Methane has a lower GWP of 28-36 compared to the much higher Nitrous oxide GWP of 265-298.**

Question 17

Climate scientists gain an understanding of past climate activity through the study of ice cores. The small bubbles of gas found in the ice can be extracted and analysed to determine historic atmospheric concentrations. Which of the below gases *cannot* be studied with this technique?

- A. Methane.
- B. Oxygen.
- C. Halons.
- D. Carbon dioxide.

Question 18

The United Nations body that prepares regular Assessment Reports outlining the state of scientific, technical and socio-economic knowledge of climate change is called

- A. The United Climate Change Panel.
- B. The International Panel on Climate Change.
- C. The United International Panel for Climate Change.
- D. The Intergovernmental Panel on Climate Change.

Question 19

Scientists use complex **mathematical representations** of the climate to help us understand and predict future climate change. These are called

- A. climate models.
- B. proxy records.
- C. circulation graphs.
- D. temperature anomalies.

Question 20

Climate change affects living organisms, and it is thought that over the next two decades it will become the number one threat to Earth's biodiversity. Which of the below would not be considered an effect of climate change?

- A. Reduced ecosystem resilience.
- B. Reduction in genetic diversity.
- C. Increased extinction rates of species.
- D. Increased pollination services by species.

Question 21

The greenhouse effect is a result of interactions of solar radiation with the Earth's atmosphere and surface. Which of the below forms of radiation is **absorbed by ozone** in the stratosphere?

- A. Infrared radiation.
- B. Ultraviolet radiation.
- C. Visible light.
- D. Gamma.

Question 22

The human population can respond to climate change with both mitigation and adaptation strategies. Which of the below is an example of an adaptation strategy?

- A. Turning off lights in a room when the room is empty.
- B. Walking to school instead of driving in a car.
- C. Weather proofing design features in new buildings to make them stronger in storm conditions.
- D. Increasing the number of houses that have solar panels by reducing the cost of their purchase and installation.

***Option C is correct as this is an adjustment (adaptation) to cope with the impacts or potential impacts. All other options are aimed at reducing greenhouse gas emissions.**

Question 23

Which energy source has the potential to reduce anthropogenic greenhouse gas emissions?

- A. Oil.
- B. Natural Gas.
- C. Hydropower.
- D. Petroleum.

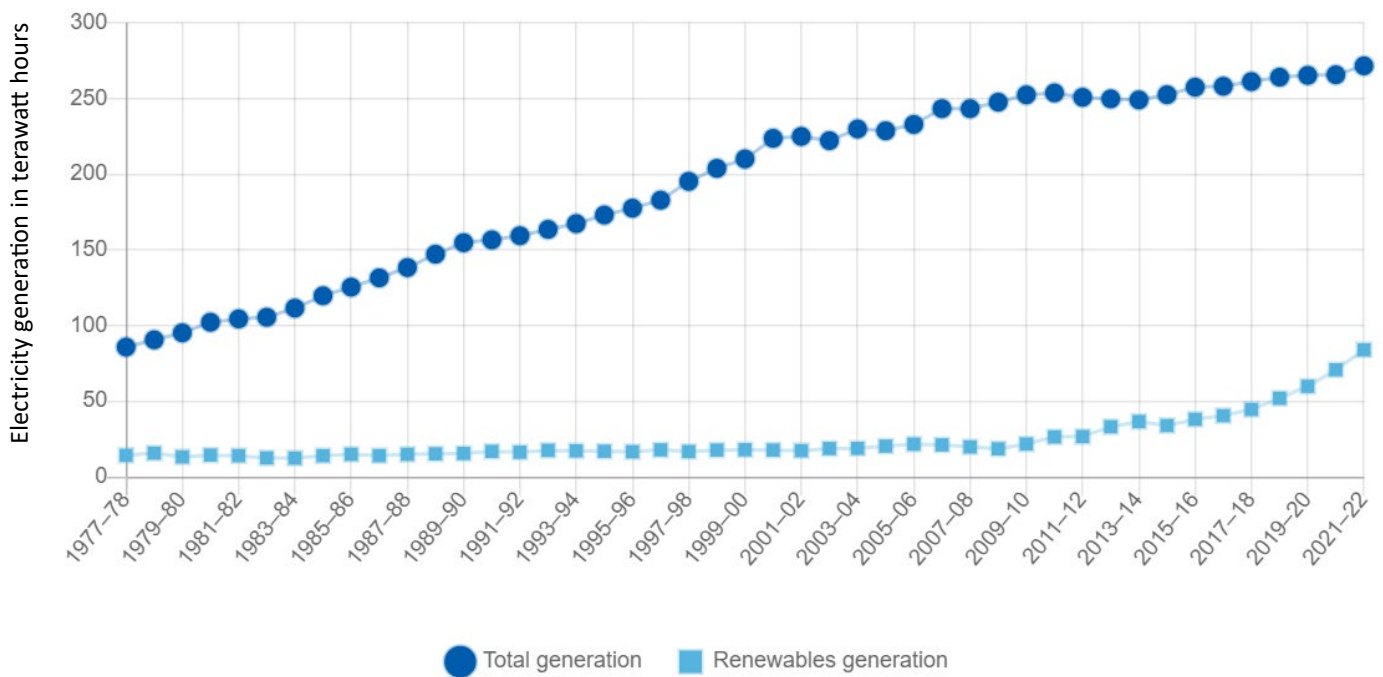
Question 24

The rotation of the blades on a wind turbine is a form of what energy?

- A. Potential.
- B. Kinetic.**
- C. Nuclear.
- D. Chemical.

Use the following information to respond to Questions 25 & 26

This graph demonstrates total electricity generation and renewable electricity generation in terawatt hours from 1977-78 to 2021-22 in Australia.



Source: Australian Government: Department of Climate Change, and Energy, and the Environment and Water 2024.

<https://www.energy.gov.au/energy-data/australian-energy-statistics>

Question 25

The percentage increase of renewable electricity generation in terawatt hours from 1977 to 2022 is approximately:

- A. 18%
- B. 75%
- C. 180%
- D. 300%**

***Option D is correct.**

1977-78 terawatt hours produced = ~20

2021-22 terawatt hours produced = ~80

80-20 = 60

60/20 *100 = 300%

Question 26

In 2021-2022 what percentage of **total electricity** generation in terawatt hours was produced from renewable sources in Australia?

- A. 300%
- B. 79%
- C. 29%
- D. 180%

***Option C is correct.**

- 2021-22 electricity generation in terawatt hours produced by renewables = ~80
- 2021-22 electricity generation in terawatt hours produced by all sources combined = ~275

$$80/275 * 100 = 29\%$$

Question 27

Students in an Environmental Science class were investigating water pollution in local waterways. Which scenario highlights a potential threat to the **validity** of their water pollution test?

- A. Water samples collected from multiple locations with consistent sampling techniques.
- B. A consistent sampling technique with uncalibrated equipment.
- C. Water samples analysed and cross-referenced with historical data.
- D. Water pollution tests using a standardised scientific methodology and sharing of data between other groups in the class.

Question 28

Which option correctly differentiates between precision and accuracy in scientific measurements?

- A. Precision refers to how closely a set of measured values are to the true value, while accuracy refers to the consistency of repeated measurements.
- B. Precision refers to how closely a set of measured values agree with each other, while accuracy refers to how close a measured value is to the true value.
- C. Precision and accuracy are interchangeable when describing reliability of measurements.
- D. Precision refers to the reliability of scientific instruments, while accuracy refers to the how easily the experimental results are repeatable.

Use the following information to answer Questions 29 & 30

Conservationists developed a method to estimate insect diversity at Mt Rothwell Conservation and Research Reserve – an area consisting of basalt plains; granite rocky outcrops; and open grassy woodland.

Question 29

Which scenario highlights a potential source of systematic error in their experimental design?

- A. Collecting insects using a trap design for larger species as they are easier to count.
- B. Collecting insects using a variety of trapping methods such as pitfall, sweep nets, and light traps.
- C. Collecting insects from a variety of locations across the grasslands.
- D. Sampling efforts are conducted during different times of the day and across multiple seasons.

Question 30

Which option best illustrates **quantitative** data that the conservationists gathered?

- A. The total **number** of individual species found in the Reserve.
- B. Descriptions of various insect species found in the Reserve.
- C. Categories of flora species that insect species demonstrated a preference for.
- D. Detailed accounts of interactions between the insect species and other fauna species.

End of Section A.

Section B (90 marks)

Instructions for Section B

Answer all questions in the spaces provided.

Question 1 (10 marks)

The Black Summer Bushfires of 2019-2020 burnt an unprecedented area of Eastern Australia, with severe economic, environmental, and human impacts.

Of significance to Victorian biodiversity, 6317 hectares of Victorian rainforest was burnt during the bushfires representing 18% of the total amount of rainforest in Victoria. During the summer of 2019-20, bushfires burned around 6,300 ha of rainforest at high severity.

Conservation scientists are concerned about the impact of the fires on rainforest ecosystems in Eastern Victoria. As part of their investigations, scientists sampled a typical rainforest location impacted by the fires. Scientists used quadrats to record plant species present and the total number of organisms of each individual species.

Source: *Department of Environment, Land, Water and Planning, Melbourne, Victoria.*
Creative Commons Attribution 4.0 International licence

- a. Describe one factor scientists should consider in determining the shape of the quadrats used for sampling the rainforest site. 2 marks

The shape of the quadrat will affect the significance of the edge effect (when an animal or plant is at the edge of a quadrat) (1 mark).

Using a circle will minimise edge effects but the area of a circle is more difficult to calculate than the area of a square (1 mark).

Other answers about shape may be acceptable

- *The shape of a quadrat can vary depending on what is being sampled and where, if the same shape is used throughout the study*
- *The ratio of edge length to inner area changes as follows: circle < square < rectangle.*

The rainforest site was used in a previous study before fire impacted the site. Plant species present and the total number of organisms of each individual species were recorded.

Simpson's Index of Diversity (SID) was calculated by the scientists to measure species diversity of the site.

SID can be calculated using the following formula.

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

- b. What does n_i represent in the formula? 1 mark

n_i represent the total number of organisms of each individual species (1 mark).

The data collected before and after the fire is recorded in table below.

- c. Use the figures in the table and the spaces provided to calculate SID for the site after fire. The SID value before fire has already been calculated. 3 marks

	Before 2020 fire				After 2020 fire		
Species	n_i	$n_i - 1$	$n_i (n_i - 1)$		n_i	$n_i - 1$	$n_i (n_i - 1)$
Southern Sassafras	6	5	30		0	0	0
Lilly Pilly	8	7	56		0	0	0
Jungle Grape	10	9	90		0	0	0
Rough Tree-fern	13	12	156		11	10	110
Soft Tree-fern	10	9	90		8	7	56
Musk Daisy-bush	20	19	380		9	8	72
Shiny Shield-fern	4	3	12		15	14	210
Cat's-ear	0	0	0		10	9	90
Spear Thistle	0	0	0		6	5	30
Blackberry	0	0	0		8	7	56
N = N-1 =	71 70		$\Sigma[n_i (n_i - 1)]$ = 814		N= 67 N-1 = 66		$\Sigma[n_i (n_i - 1)]$ = 624
N (N-1) =	4970				N(N-1) =	4422	
		SID =	$1 - \frac{814}{4970}$			SID =	$1 - \frac{624}{4422}$
		SID=	1 - 0.164			SID=	1 - 0.141
		SID=	0.836			SID=	0.859

- Teacher discretion example:
 - 3 marks if table correct
 - 2 marks for table correct and wrong SID calculation
 - 1 mark for either correct SID only and no table values or mostly correct table values

- d. Evaluate whether the species diversity has increased or decreased after fire at the rainforest site according to SID. 2 marks

According to SID, the species diversity has increased after fire (1 mark)

because the index increased from 0.836 before fire to 0.859 after fire (1 mark).

- e. After conducting research into Victorian rainforest ecosystems, an Environmental Science student notes that Cat's-ear, Spear Thistle, and Blackberry are weed species while Southern Sassafras and Lilly Pilly are important canopy species. Using this new information and the data in the table above, describe a limitation of Simpson's Diversity Index as a measure of species diversity. 2 marks

Weed species and native species are given equal value in calculating SID (1 mark).

This does not represent the true health of the ecosystem (1 mark).

Question 2 (11 marks)

The Eastern Quoll is a medium-sized carnivorous marsupial that was once found throughout south-east Australia and in Tasmania. It disappeared from the Australian mainland last century, due to disease, predation by foxes and feral cats, and poisoning. The Eastern Quoll is currently listed as Endangered under the EPBC Act.

Source: Department of Climate Change, Energy, the Environment and Water. Creative Commons Attribution 4.0 International licence

- a. As carnivores, Eastern Quolls help control pest insects thereby providing an ecosystem service that benefits human health and well-being. State the category of ecosystem service that this predation belongs to and provide a reason for your response. 2 marks

Regulating service (1 mark).

The activities of predators in ecosystems act to control populations of potential pest and disease vector which regulates the ecosystem (1 mark).

- b. Current populations of the Eastern Quoll are small and have low genetic diversity. Disease is potentially a severe threat to the future viability of Eastern Quoll populations. Outline how low genetic diversity makes Eastern Quolls vulnerable to disease. 2 marks

A population with more genetic diversity can respond more effectively to changes in the environment such as disease (1 mark) as it is more likely to include individuals with natural resistance to the disease (1 mark).

- c. In April 2024, 19 captively bred Eastern Quolls were released into a purpose-built wildlife enclosure at Booderee National Park in New South Wales. The 80-hectare sanctuary at the park's Botanic Gardens has a 1.8-metre-high fence with a curved umbrella top to help protect Eastern Quolls from introduced predators like foxes.
Provide **one** advantage and **one** disadvantage of this captive breeding and reintroduction program as a strategy for reducing the risk of extinction of the Eastern Quoll. 2 marks

One advantage (1 mark)

- *Captive breeding increases population numbers.*
- *Reintroductions can increase geographic range.*
- *Raises awareness about endangered species and their conservation needs.*

One disadvantage (1 mark)

- *Captive populations may experience genetic problems such as reduced genetic diversity, inbreeding and loss of adaptive traits, which can weaken the overall health of the species.*
- *Captive breeding can lead to behavioural changes in individuals, including reduced natural behaviours such as hunting or foraging instincts, which may affect their ability to survive in the wild.*
- *Maintaining captive breeding programs is expensive.*

- d. According to the IUCN Red List, the Eastern Quoll's current conservation status is endangered. If captive breeding and other strategies lead to a reduction in the risk of extinction, state the possible new conservation category of the Eastern Quoll. 1 mark

Vulnerable

- e. Describe one quantitative assessment indicator that would be used to provide evidence that the Eastern Quoll has an improved conservation status. 2 marks

One indicator (1 mark)

- *Availability of suitable habitat.*
- *Geographic distribution.*
- *Population size.*

AND a relevant description specific to the Eastern Quoll (1 mark).

- f. Outline one practical technique that could be used to measure the indicator described in *part e*.

2 marks

One suitable fieldwork sampling technique for collecting biodiversity data **must** relate to indicator described in part e (1 mark).

Brief outline (1 mark).

- *Mark-recapture, sampling with grids, transects and quadrats.*
- *Brief outline.*

Question 3 (11 marks)

Sydney Harbour, New South Wales is one of the largest natural harbours in the world with a catchment area of 55.7km². It has an open entrance and complex shoreline. The Harbour and its tributaries hold significant cultural, heritage, recreational and economic value (transport, maritime, defence and tourism industries). Over the last two centuries 50% of the shoreline has been modified with as seawalls, pilings, pontoons, marinas, and energy generation and communications infrastructure. Climate change is intensifying the threat to the ecosystem, with changes to water quality, temperature, and tidal patterns.

20 years of research into declining biodiversity and water quality of Sydney Harbour, has prompted the installation of artificial habitats to reverse this trend. Locally sourced sandstone blocks are carved into complex, sloped and stepped panels to follow the historic and natural shoreline, headlands, and coves. These habitats will replace current vertical concrete seawalls. The panels increase available habitat and mimic natural features of the ecosystem. The panels also provide protection to marine life from predators and environmental stressors such as impacts of climate change, and the stepped design enables people to access the marine environment. Each sandstone panel is expected to last at least 20 years.

Since 2018, more than 900 panels have been installed in the harbour. Researchers found that within hours of installation microscopic organisms and invertebrates inhabited the modules, and within several few months, the panels were crowded with marine life. After 1-2 years there was a 36% increase in fish, seaweed, and invertebrate numbers compared to unmodified seawalls. 85 species of invertebrates, seaweeds, and fish were found to be living on the panels – which is comparable to biodiversity hotspots found nearby. Improved water quality has also been recorded. Natural weathering of the sandstone will result in more rock pools and an increase in algae species.

Information adapted from: <https://www.environment.nsw.gov.au/topics/water>; <https://news.unsw.edu.au/en/inside-the-mission-to-restore-the-waters-of-sydney-harbour>; <https://soe.dcceew.gov.au/coasts/case-studies>

- a. Describe the role that residents or business owners could have in the decision-making process for the living sea wall project.

1 mark

Example (1 mark):

- *Local knowledge.*
- *Contribute suggestions to alternatives or mitigation strategies.*
- *Suggest potential impacts to the local community.*
- *Suggest potential impacts on economics if the project does/does not go ahead.*
- *Long term engagement in the project to ensure its success.*

- b. Explain how the Precautionary Principle should have been applied to this case. Make clear the definition of the principle in your response. 2 marks

Example

Where there were identifiable serious or irreversible damage to the environment (1 mark), further investigation into the ecological effects of the sea wall project and any appropriate mitigation measures should have been established prior to commencement of the project (1 mark).

Definition example:

An incorrect decision in biodiversity management is irreversible if it involves the loss of a species or ecological process, so extreme care in biodiversity planning is necessary.

Or

Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

- c. Describe how local Indigenous knowledge will assist in the success of this project. 1 mark

Example (1 mark)

- *Indigenous knowledge often includes traditional practices that have been developed and refined over generations to sustainably manage natural resources.*
- *Indigenous culture often has long standing knowledge and understanding of an area that can contribute to effective biodiversity planning.*

- d. Identify one cost and one benefit of the sea wall project related to the sustainability dimensions in the table below. 2 marks

	Cost	Benefit
Social (1 mark for two responses)	<i>Community conflict related to differing opinions on the project.</i> <i>Aesthetic impact of artificial sea walls may impact appeal and community connectedness to the area.</i>	<i>Improved coastal resilience leading to greater public safety as weather extremes/erosion/sea level rises continue.</i> <i>Educational and recreational opportunities</i>
Economic (1 mark for two responses)	<i>Long term viability of using locally sourced sandstone.</i> <i>Initial construction and ongoing maintenance.</i> <i>Disruption to local businesses during construction.</i>	<i>Coastal property protection.</i> <i>Tourism and recreation revenue.</i>

e. Critics of the living sandstone sea wall have claimed:

"This project is not sustainable. The sandstone panels will require replacing every 20 years due to natural erosion. Concrete panels should be the preferred option".

Do you agree or disagree with this statement? Justify your opinion by using the sustainability principles - Conservation of Biodiversity and Ecological Integrity **and** Efficient Resource Use. Make clear the definition of the principles in your response.

5 marks

Agree (1 mark)

Reference to Conservation of Biodiversity and Ecological Integrity (1 mark):

- Protection and maintenance of biodiversity and ecological services provided by an ecosystem.*

Reference to any of (1 mark):

- Habitat protection/enhancement.*
- Vulnerable species protection.*
- Enhancement of ecosystem services leading to improved water quality etc.*

Reference to Efficient Resource Use (1 mark):

- Minimising waste, reducing costs and improving environmental sustainability performance.*

Reference to any of (1 mark):

- Local sandstone reduces the need for energy consumption to transport and create concrete panels.*
- Less greenhouse gas emissions using locally sourced sandstone (concrete produces large amounts of GHGs and is energy intensive).*

Question 4 (7 marks)

Sea Forest is a Tasmanian company dedicated to fighting climate change. The team cultivates *Asparagopsis*, a red seaweed native to the waters of Tasmania which has a high average growth rate with the biomass of the plant increasing between 7% to 13% per day. Approximately 40% of its biomass is made up of carbon. *Sea Forest* farms *Asparagopsis* both in the ocean and in land-based tank systems. *Sea Forest* collects bioactives created by the plant that when added to livestock feed in low quantities can greatly reduce the production of methane gas from these animals. Additionally, the scientists at the company have successfully replicated these chemicals to create a synthetic version which can be added to livestock feed.

Source: <https://www.seaforest.com.au/>

a. Describe the impact that ocean farming of *Asparagopsis*' could have on the hydrosphere and atmosphere.

2 marks

Hydrosphere impact (1 mark)

- Improved water quality such as dissolved oxygen content or reduction in pH changes due to carbon dioxide absorption.*
- Improved water quality through nutrient cycling, sedimentation and breakdown of organic matter*

AND

Atmosphere impact (1 mark)

- Reduced greenhouse gas emissions in the troposphere that lead to the enhanced greenhouse effect.*
- Carbon sequestration.*
- Improved air quality.*

- b. Judy and Mel were learning about *Sea Forest* in their Environmental Science class. Judy claimed that the company's approach to tackling climate change was one of mitigation while Mel argued that it was one of adaptation. Explain which student is correct, including definitions of climate change mitigation and adaptation in your answer. 3 marks

Judy is correct (1 mark)

Climate change mitigation is processes or actions that reduce net greenhouse gas emissions to slow climate change demonstrated by the seaweed sequestering carbon dioxide from the ocean leading to a reduction in greenhouse gas emissions in the atmosphere (1 mark).

(Or The seaweed chemicals in the livestock feed is also mitigated as this results in methane emissions from livestock being reduced).

Whereas climate change adaptation is processes or actions that alter the way humans live to increase resilience to the inevitable effects of climate change (1 mark).

- c. *Sea Forest* is working directly with farmers to reduce methane emissions from their livestock. Identify and describe one other agricultural practice that leads to increased greenhouse gas concentrations in our atmosphere. 2 marks

Identify (1 mark) & Describe (1 mark).

Examples:

- *Turning (tilling) the soil after crop harvest in preparation for new crop plantings (1) releases carbon dioxide into the atmosphere (1).*
- *Rice paddy cultivation relies on waterlogged soils (1) that create anaerobic conditions and result in methane production (1).*
- *Use of synthetic fertilisers in agriculture to provide essential nutrients such as nitrogen, potassium and phosphorous (1). Through the nitrification process in the soil, nitrous oxide is formed and emitted into the atmosphere (1).*

Question 5 (14 marks)

This year the world reached a concerning climate milestone. Between June 2023 to May 2024 there was unprecedented global heat, with data showing that May 2024 was the hottest May on record. This global warming is a result of the enhanced greenhouse effect.

Source: https://www.abc.net.au/news/2024-06-05/world-the-hottest-on-record-12-months-in-a-row/103904150?utm_campaign=abc_news_web&utm_content=link&utm_medium=content_shared&utm_source=abc_news_web

- a. Outline the natural greenhouse effect, indicating the three main types of incoming radiation and describing how these interact with the atmosphere and the Earth's surface. 3 marks

Incoming radiation types are ultraviolet light, infra-red radiation and visible light (1 mark).

The visible light is absorbed by Earth's surface and re-radiated as infra-red, with some reflection. This re-radiated infra-red is absorbed by natural greenhouse gases in the troposphere and heats the atmosphere (1 mark) allowing life on Earth to exist.

Much of the incoming ultraviolet is absorbed by the ozone layer in the stratosphere and incoming infra-red is absorbed in the lower atmosphere before it reaches Earth's surface (1 mark).

b. Compare the natural and enhanced greenhouse effects.

3 marks

**This is a comparison question and as such the answer must give an account of the similarities and differences.*

Both the natural and enhanced greenhouse effects result in changes to Earth's temperature (1 mark).

The natural greenhouse effect involves naturally occurring levels of greenhouse gases in the troposphere that result in a temperature that makes Earth suitable for life (1 mark) whereas the enhanced greenhouse effect involves higher levels of greenhouse gases due to anthropogenic activity which in turn result in the Earth's temperature being increased leading to global warming and climate change. These are not conducive to life on Earth as we know it (1 mark).

One of the direct effects of global warming caused by the enhanced greenhouse effect is melting sea ice and glaciers which alters their interactions with solar radiation. This is due to the albedo effect.

c. Identify the surface that would have a higher albedo, a polar ice cap or the deep ocean. Justify your response and include a definition of albedo in your answer. 3 marks

Albedo is the fraction of solar energy that is reflected into space from Earth (1 mark). As the polar ice cap is lighter in colour than the deep ocean it will reflect more solar energy back into space (1 mark) and thus have a higher albedo (1 mark).

d. Climate scientists have confirmed that the ice-albedo feedback is leading to increased amounts of snow and ice melting. Describe this feedback process. 3 marks

As the atmospheric temperature increases there is more melting of the Earth's snow and ice (1 mark). This means more solar radiation is absorbed by the Earth's surfaces as they are now darker (have a lower albedo) (1 mark). This increased absorption leads to warming of the earth's surfaces which in turn causes more snow and ice to melt (1 mark).

e. Due to Australia's varied and diverse ecosystems, climate modelling is used by scientists researching ice-albedo feedback and climate change. This data is used when developing mitigation plans. Explain one advantage and one disadvantage of using this data. 2 marks

Advantage

- *Allows for simulation of potential events that can be mitigated for in advance (1 mark).*

Disadvantage

- *Reference to natural complexities and events, and uncertainties such as incomplete data sets that cannot be planned for (1 mark).*

Question 6 (11 marks)

In March 2024, the Victorian Government awarded grants to 20 towns to install neighbourhood batteries under the first round of the *100 Neighbourhood Batteries Program*. Neighbourhood batteries store energy generated by domestic solar systems for later use. The government claims that these batteries also “enable households to generate and consume more renewable energy locally – helping to drive down power bills”. The largest battery project to be funded in this first round is on Phillip Island with seven 250-kilowatt hour (kWh) batteries to be installed providing 1750 kWh of storage.

Source: State of Victoria (*Department of Energy, Environment and Climate Action*) Creative Commons

- a. Families in the community who wish to participate in this project have claimed that the batteries will be of benefit to them as cost-of-living pressures rise. Identify which of the sustainability principles this applies to. Justify your response. 2 marks

The principle of Intragenerational Equity (1 mark).

In this case the use of battery storage systems means that the energy needs of the current generation on the island will be met (1 mark).

**Could use Intergenerational Equity or Efficiency of Resource Use (1) if justified (1).*

- b. With the installation of the Phillip Island batteries the local council is predicting an increased rate of installation of rooftop solar systems on the island. Describe one advantage and one disadvantage of solar generated electricity. 2 marks

Multiple options available.

Advantage (1 mark)

- *Reduced greenhouse gas emissions compared to fossil fuel generation of electricity*
- *Energy is usually generated at or near to the location it will be used, keeping transmission and distribution costs to a minimum*
- *Useful to generate electricity in remote places where other electricity supplies are hard to access*
- *Renewable.*

AND

Disadvantage (1 mark)

- *Cost to the consumer is high to install*
- *Manufacture of cells produces pollution and utilises a large amount of energy*
- *Mining of silicon from sand has impacts on the environment*
- *Do not work as effectively when cloudy, or at night. – intermittent and not always predictable.*

- c. Before the community batteries program, many residents of Phillip Island had rooftop solar panels. Excess electricity generated by their solar systems was sent back into the grid. Explain why supporters of the new community battery project say that this program will provide a more efficient source of electricity than relying on rooftop solar systems alone. 2 marks

If residents are accessing energy from the grid, then it must travel longer distances and as such some is lost (as heat) during transmission (1 mark). In contrast the community batteries are located closer to the homes where the electricity can be stored and therefore less energy is lost during transmission (thereby increasing efficiency) (1 mark).

- d.** Thirty years ago, the Phillip Island community did not have access to renewable energy sources and relied upon coal-generated electricity. Identify a fossil fuel - other than coal - and describe one advantage and one disadvantage of using it to generate electricity. 3 marks

Example (1 mark)

- *Natural gas OR CSG OR Oil/Petroleum (unlikely for electricity generation but student gains a mark for correctly naming a fossil fuel)*

Advantage (1 mark)

- *Abundant supply in Australia.*
- *Able to be combusted 24/7 and supply base and peak loads.*

Disadvantage (1 mark)

- *Greenhouse gas emissions when combusted contribute to enhanced greenhouse effect.*
- *Impacts of mining on bio/litho/atmo/hydrosphere*
- *CSG - extraction process contaminates ground water; may cause seismic activity.*

- e.** Coal used for electricity generation is obtained through mining. Once the mine is depleted of the coal, rehabilitation must take place. Identify and describe one mining rehabilitation technique that could be used to restore a coal mine. 2 marks

One of:

Biological rehabilitation (1 mark).

- *Replanting vegetation and then reintroducing other organisms into the mine site (1 mark).*

Mechanical rehabilitation (1 mark).

- *Requires components of the mine site to be physically removed or added. May include excavating and taking away contaminated soils or adding soils back to replace those that were lost during the mining period (1 mark).*

Question 7 (13 marks)

In Australia the increasing demand for reliable energy is an ongoing problem for Governments. This issue has again raised the debate around nuclear power in Australia. Two current energy production proposals in Victoria include:

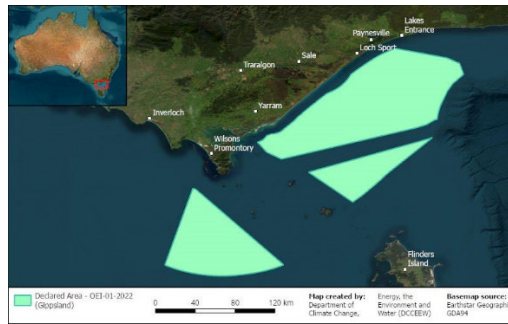
Proposal 1:

A nuclear power station in Victoria at the Loy Yang coal power stations near Traralgon (located on the map below). Existing coal mine infrastructure, including the cooling resources will be used along with new infrastructure to build the nuclear reactor. A nuclear power station on this site potentially ensures 2.2 Gigawatts of constant energy and a yet unknown number of ongoing jobs and temporary construction jobs.

Proposal 2:

An offshore windfarm project proposed for the area (pictured below) off Lakes Entrance, in the east, and to the south of Wilsons Promontory, in the west. The area was declared by the Government in 2022 and covers approximately 15,000 square kilometres. The wind farm will use existing and new energy infrastructure. It has the potential to generate 25 Gigawatts of energy and create 15,000 jobs during construction and 7,500 ongoing jobs.

Section B continues.



Source: Department of Climate Change, Energy, the Environment and Water. 2024. *Renewable Energy*;
https://www.dcceew.gov.au/energy/renewable/offshore-wind/areas/gippsland#toc_0

a. Explain why the Australian public may be against the use of nuclear power in Australia. 2 marks

Fears associated with potential nuclear accidents and/or radioactive waste (1 mark) that would have adverse effects on human health and/or ecosystem health (1 mark).

Other options may include:

- *Still requires mining of a finite natural resource which disrupts biodiversity and ecosystems health.*
- *High costs associated with nuclear construction and supply of energy.*
- *Impacts on indigenous communities and important cultural sites.*
- *Renewable alternatives available with less risk*
- *No reliable way to dispose of or treat nuclear waste – long-term environmental concerns*
- *Whereas nuclear power is resource intensive; requires mining of a finite resource; produces radioactive waste management issues for generations; decommissioning and dismantling of a nuclear station has challenges associated with human and environmental health, and economics.*

b. Describe **one** advantage and **one** disadvantage of the offshore wind farm. 2 marks

One each of related to the scenario mentioned:

Advantage (1 mark)

- *Large amounts of energy will be produced (25GW) due to strong and consistent wind resources.*
- *Reduction in land conflict issues that would be advantageous in environmentally sensitive or agricultural areas.*
- *Using existing infrastructure will limit the overall number of new resources needed to be sourced.*
- *High number of temporary and ongoing jobs to help stabilise economy.*
- *Renewable*
- *More energy generated than the nuclear option*

Disadvantage (1 mark)

- *Costs/difficulties associated with construction and maintenance of infrastructure can be high.*
- *Impacts to marine ecosystems and sea birds.*
- *Impacts on fishing, tourism and recreational industries.*
- *Amount of energy generated could fluctuate dependant on conditions*
- *Management of end-of-life for the wind turbine components due to the size would require significant funds and resources to transport back to shore*
- *Complexity of the turbine material may make separation and recycling difficult.*
- *Disruption to established marine environments during removal and transport.*

- c. Explain why circular economy thinking is critical when developing a sustainable energy plan for Victoria. Include a definition of circular economy thinking in your explanation. 4 marks

Circular economy thinking aligns with the pillars of ESD – Social, Economic and Enviro through models that are designed to maximise resource efficiency, close material loops, minimise waste, (1 mark) and promote long-term environmental sustainability (1 mark).

Reference/elaboration/examples (2 marks):

- *Resource Efficiency*
- *Waste and Management*
- *Conservation*
- *Climate Change Mitigation*
- *Social Benefits*
- *Economic Benefits*
- *Policy Integration (to achieving sustainable development objectives)*

- d. In your opinion, which proposal best represents an Ecological Sustainable Development and should therefore be recommend to the Government? Justify your response. 5 marks

Opinion:

- *Proposal 1 or 2 (1 mark).*

Justification:

- *ESD is development that meets the needs of the current generation without compromising future generations meeting theirs (1 mark).*
- *Reference to how proposal supports Social, Economic and Environmental pillars of ESD (2 marks).*

Comparison to opposing proposal (1 mark).

Question 8 (13 marks)

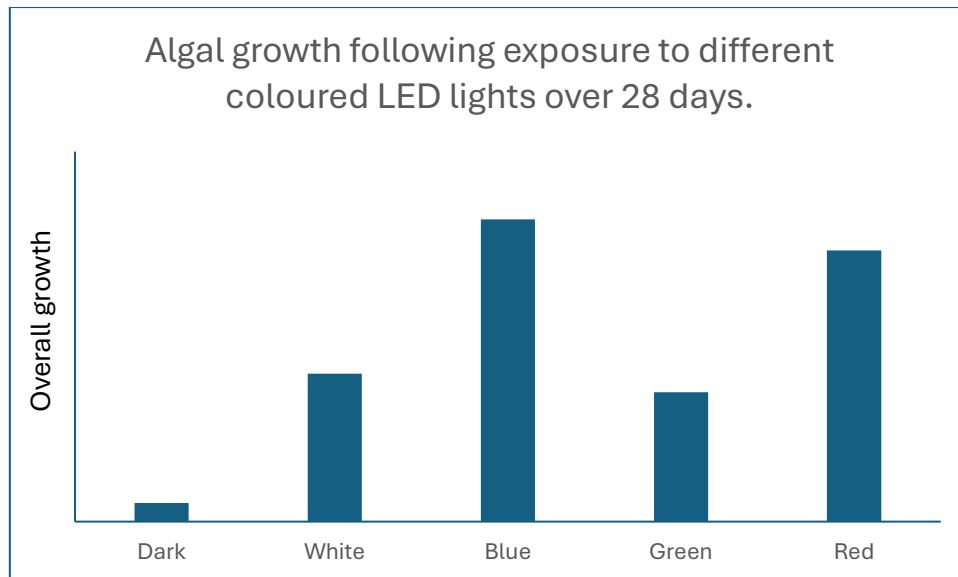
Along a section of the Victorian coastline, park rangers recorded an increase in population numbers of phytoplankton species and algal blooms. These were occurring within tourist areas where artificial lighting was in high use for night-time activities. Local Environmental Science students developed a laboratory experiment to investigate the best type of lighting to use in these areas to minimise imbalances in the phytoplankton communities and reduce overall algal blooms.

Students set up five test stations in the laboratory with each station containing identical algal communities resembling those found along the section of coastline that recorded the highest incidence of algal blooms. Stations 2-5 were exposed to different coloured LED lights and Station 1 was placed in the dark.

- Station 1 – placed in the dark with no exposure to LED light
- Station 2 – exposed to artificial white LED light
- Station 3 – exposed to artificial blue LED light
- Station 4 – exposed to artificial green LED light
- Station 5 – exposed to artificial red LED light

Students measured algal growth each day for 28 days and presented their results in the graph below.

Section B – Q8 continues



- a. Write a hypothesis that the students could use for this experiment. 2 marks

Many options – must include:

If (independent variable) (1 mark), then (dependent variable) (1 mark).

- b. Identify the control group in this experiment. 1 mark

Control group = Station 1 – dark.

- i. Explain the importance of using a control in this investigation. 2 marks

Reference to the control giving a baseline for comparison (1 mark) of the dependent variable (1 mark).

- c. Identify the following variables in this investigation

- i. Independent variable - *Coloured light* 1 mark
ii. Dependent variable – *Overall growth* 1 mark

- d. How can the students demonstrate the reproducibility of their investigation? 2 marks

Students should be able to demonstrate a closeness of the agreement between the results of measurements of the same quantity being measured, carried out under changed conditions of measurement (1 mark).

These changed conditions include a different:

Any of (1 mark):

- Method of measurement, different observer, different measuring instrument, different location, different conditions of use, and different time.*

Source: VCAA Environmental Science Study Design 2022-2026: Page 16.

- e. Describe the impact on the local ecosystem if the increased algal blooms are not managed. 2 marks

One impact on ecosystem (1 mark) with some elaboration (1 mark).

Examples:

- Water quality degradation (1) leading to loss of native species (1).*
- Loss of biodiversity or native species (1) due to competition for resources resulting in disruptions to food chain (1).*

- Degradation of water quality (1) reducing resilience of the ecosystem to environmental change (1).
- Toxins from algal blooms (1) can disrupt food chain/reproduction patterns/water quality (1).

f. Based on this investigation, what type of LED lights should be used to minimise algal blooms along the coastline where visibility is required for humans at night. Justify your response using the data above. 2 marks

Green LED lights should be used (1 mark).

Reference to data (1 mark).

End of Examination.

STUDENT NUMBER: _____ - _____ - _____ - _____

STUDENT NAME _____ CLASS: _____



**Victorian Certificate of Education 2024
Environmental Science Written Trial Examination**

Multiple-choice Answer Sheet

Circle the response that is correct or that best answers the question.

1. A B C D	16. A B C D
2. A B C D	17. A B C D
3. A B C D	18. A B C D
4. A B C D	19. A B C D
5. A B C D	20. A B C D
6. A B C D	21. A B C D
7. A B C D	22. A B C D
8. A B C D	23. A B C D
9. A B C D	24. A B C D
10. A B C D	25. A B C D
11. A B C D	26. A B C D
12. A B C D	27. A B C D
13. A B C D	28. A B C D
14. A B C D	29. A B C D
15. A B C D	30. A B C D