STUDENT NUMBER: ____ ____ - ____ ____ ____ - ____ ____ ____ - ____

STUDENT NAME: _____ CLASS: _____

ENVIRONMENT EDUCATION VICTORIA

Victorian Certificate of Education 2023

Environmental Science

Trial Written Examination

SUGGESTED SOLUTIONS HIGHLIGHTED OR IN RED

Reading time: 15 minutes
Writing time: 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	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 27 pages
- Answer sheet for multiple-choice questions

Instructions

- Write your student number, name and class in the space provided above on this page.
- Write your student number, name and class in the space provided on your answer sheet for multiple-choice questions.
- 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 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

Australian reptile numbers are in decline with the proportion of species being declared as critically endangered increasing. The reduction in species diversity is most likely due to

- **A.** lack of monitoring techniques to measure species diversity.
- **B.** introduced plants and animals.
- **C.** being located in protected areas.
- **D.** reduction of investment in conservation of reptiles.

Question 2

Soil contaminants that reach groundwater can affect crop yield, food availability, and the quality of drinking water. In this case, what type of ecosystem service is impacted by soil contaminants?

- **A.** Provisioning service
- **B.** Regulating service
- **C.** Supporting service
- **D.** Cultural service

Use the following information to answer Questions 3 and 4

Question 3

The Litchfield National Park in the Northern Territory covers approximately 1,500 km^2 and has been described as “an ancient landscape shaped by water”. With its stunning waterfalls, sandstone structures, and walking paths it is a cherished tourist attraction. Over recent years the park’s biodiversity has been impacted by the introduction of Gamba grass which has spread throughout the park.

Litchfield National Park is a major tourist destination in the Northern Territory, and is significant to the local Aboriginal people, making it an example of a

- **A.** provisioning service.
- **B.** regulating service.
- **C.** supporting service.
- **D.** cultural service.

Question 4

To determine the extent of the spread of the Gamba grass and its impact, practical techniques were undertaken by scientists to assess the changes in species diversity. The most suitable technique chosen by the scientists would be

A. mark and recapture.
B. quadrats.
C. direct observation.
D. indirect signs.

Use the following information for Questions 5 and 6

The Growling Grass Frog has been classified as vulnerable in Victoria. Flood conditions lead to ideal breeding conditions for this species.

Question 5

If Victoria experienced successive years of rain, and the population subsequentially increases, the Growling Grass Frog conservation status would most likely be

A. vulnerable.
B. near threatened.
C. endangered.
D. critically endangered.

Question 6

As a threatened species in Victoria, the Growling Grass Frog is locally protected under the

A. Convention on International Trade in Endangered Species (CITES).
B. International Union for Conservation of Nature (IUCN).
C. *Flora and Fauna Guarantee Act 1988.*
D. *Australian Biodiversity Act 2021.*

Question 7

Symbionts affect the reproduction and persistence of species by shaping biodiversity at ecological and evolutionary scales. Which of the examples below best represents such a symbiotic relationship?

A. A hermit crab using the shell of a dead gastropod for shelter and protection from predators
B. Maggots living on a dead organism
C. Bioluminescent bacteria living in the Hawaiian bobtail squid allowing the squid to seemingly 'disappear' from below
D. A zebra and antelope feeding in the same grassland

Question 8

After years of land clearing in Victoria fragmented areas of vegetation have become common with woodland patches occurring on small pockets especially around farms. Remnant woodlands can be a source of species diversity and key to biodiversity in the area, and should be maintained via

A. removing fallen timber to reduce fire risk.
B. limiting the number of dead trees in the area.
C. using fences to limit access by livestock.
D. germinating seeds from a single plant to regenerate the area.

Question 9

Once endemic to central, southern, and south-western Australia, the Burrowing Bettong is now considered extinct on mainland Australia due to feral predators. These small, nocturnal marsupials remain on arid islands in Western Australia where their burrows provide a habitat for other desert species, trap water and nutrients, and allow plant regeneration. Scientists are considering reintroducing the Burrowing Bettongs into central Australia.

Which strategy should be prioritised if the team's aim is to improve the degraded ecosystem and increase Bettong numbers in the area?

A. Maintain the Burrowing Bettong captive breeding program on the WA Islands avoiding exposing the remaining Bettong's to cats and foxes on mainland Australia.
B. Reintroduce small numbers of Burrowing Bettong into a confined area within central Australia where their numbers can be monitored.
C. Reintroduce large numbers of Burrowing Bettong into an area where remnant Bettong warrens remain.
D. Reintroduce large numbers of Burrowing Bettong into an area with predator proof fencing where remnant Bettong warrens remain.

Question 10

The decision to stop logging in a native forest has been seen as a positive for the endangered wildlife that live in the forest. Experts agree that timber sourced from alternative plantations will ensure there is no shortage of wood. The end of logging will also promote increased genetic diversity of the greater glider and self-renewal of native fauna over time. This decision is an example of the sustainability principle of

A. efficiency of resource use.
B. precautionary principle.
C. user pays principle.
D. conservation of biodiversity and ecological integrity.

Question 11

Nashulai is a community led wildlife conservation group in East Africa. They pool land rights to create wildlife corridors and train Rangers from within the community to monitor and protect wildlife from poachers. Rangers are paid for their efforts through fundraising, government grants and safari tours.

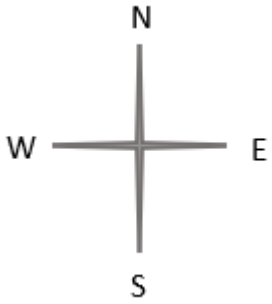
Which sustainability principle is most relevant to this example of sustainable development?

- **A.** Efficiency of resource use
- **B.** Intragenerational equity
- **C.** User pays principle
- **D.** Precautionary principle

Question 12

The Sustainability Compass is a thinking tool for exploring the different dimensions of sustainability. North is a reminder to consider the impact on Nature, South and West represent Society and Wellbeing respectively.

Given these associations which of the following would be most appropriate for East to represent?



- **A.** Ecology
- **B.** Economy
- **C.** Efficiency
- **D.** Energy

Question 13

A company responsible for the rehabilitation of an open cut coal mine was asked to reassess the impact of the proposed flooding of the mine to form a lake.

Which of the following considerations would be most consistent with Earth Systems thinking?

- **A.** The $1 Billion dollar cost looks like it would increase but the company is not sure by how much.
- **B.** The time taken for the dam to fill has increased and the local fire service is concerned that this will leave the mine vulnerable to fires for longer.
- **C.** The water quality of the proposed lake may be too poor to allow swimming and water activities, and water leaving the lake has the potential to negatively impact freshwater ecosystems downstream.
- **D.** Environment groups are concerned there will not be enough water in local waterways to fill the mine.

Question 14

Victoria's new Container Deposit Scheme (CDS) will reward Victorians with a 10-cent refund for every eligible container, can, carton or bottle.

Which of the following best supports circular economy goals with regard to the CDS?

A. It should increase recycling rates.
B. It should decrease the amount of littering.
C. It makes producers more responsible for the lifecycle of their products than previously.
D. It will be possible to direct the refund to a community group or charity.

Question 15

The acronym IPCC stands for

A. International Panel on Climate Change
B. International Panel on Climate Criteria
C. Intergovernmental Panel on Climate Criteria
D. Intergovernmental Panel on Climate Change

Question 16

The process of retaining heat in the atmosphere is called the greenhouse effect. The greenhouse effect contributes to stabilising the Earth's surface temperature. What is the approximate average temperature of the Earth's surface?

A. -15°C
B. 25°C
C. 15°C
D. -30°C

Question 17

Anthropogenic factors that affect Earth's energy balance are

A. solar variability, volcanic eruptions, and combustion of fossil fuels.
B. combustion of fossil fuels, agriculture, and deforestation.
C. solar variability, volcanic eruptions, and ocean circulation.
D. volcanic eruptions, albedo effect, and thermohaline circulation.

Question 18

The global warming potential (GWP) is a measure of how much energy can be absorbed by the emissions of 1 tonne of gas over its lifetime, relative to the emission of 1 tonne of

A. carbon dioxide.
B. nitrous oxide.
C. methane.
D. water vapour.

Question 19

The surface temperature of the Sun is high (about 5,800°C) so the wavelength of solar radiation is at the short end of the electromagnetic spectrum. The proportion of incoming radiation at the outer edge of Earth's atmosphere is highest for

A. ultraviolet radiation.
B. radio wave radiation.
C. gamma radiation.
D. visible light radiation.

Question 20

According to the Beyond Zero Emissions organisation, cement production is responsible for 8% of global carbon dioxide emissions. This is mostly due to the following process that accounts for over 55% of cement-related emissions.

A. Once the cement is made into concrete, the carbon dioxide emissions come from transportation of the finished product.
B. The key raw material of cement is limestone, which releases carbon dioxide as it is heated in a kiln.
C. The key raw material of cement is limestone, which releases carbon dioxide as it is extracted from the lithosphere.
D. Once the cement is made into concrete, the carbon dioxide emissions come from the increased albedo effect that the colour surface generates.

Question 21

Electric cars use batteries to provide electrical energy to a motor which drives the vehicle. For every 100 watts (W) of energy supplied to an electric car, 5W is lost in transmission, 10W in the charging and discharging of the battery, and 5W is lost in overcoming friction to allow the vehicle to move.

What is the percentage efficiency of the electric vehicle under these conditions?

A. 20%
B. 60%
C. 80%
D. 100%

Question 22

The following table shows the main energy sources for electricity generation in Australia in 2022.

Energy Source	Electricity Generation Australia 2022 (GWh)
Solar	29,965
Wind	25,940
Hydro	16,644
Natural Gas	13,725
Biomass	157
Coal	121,500
Total	**207,931**

Data source: Open NEM Project https://opennem.org.au/energy/nem/?range=all&interval=1y

Using data shown in the table, what is the approximate contribution of renewable energy sources to electricity generation in 2022?

A. 27%
B. 35%
C. 42%
D. 58%

Question 23

Peak oil is a concept that provides an incentive for governments to investigate alternatives to oil and petrol for transportation. Peak Oil can best be described as the point at which

A. global oil supply is used up.
B. global oil production declines due to lack of demand for oil.
C. global oil production declines due to lack of supply.
D. oil production in a particular country reaches a maximum volume.

Question 24

Researchers at Delprat Gardens are investigating the potential of plants to remove toxic material from the soil in old industrial zones. They hope to create a list of plant species that can be used anywhere in Australia to remediate soils. Initial results suggest that sunflowers, pumpkins, tomatoes, and beans are excellent at removing metal contaminants such as copper, lead, and zinc from the soil.

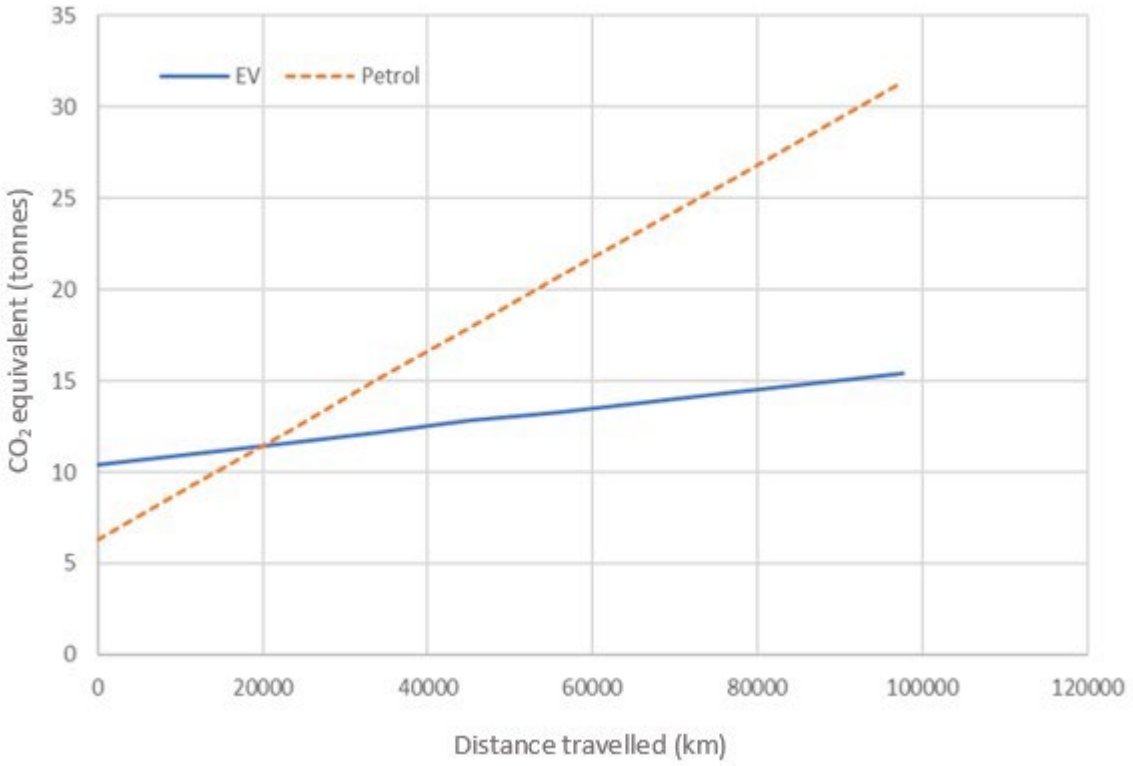
Which of the following would need to be investigated before these species could safely be planted in a potential rehabilitation site?

A. The pollinator species required to pollinate each plant species
B. The part of the plant that retains the metal contaminants
C. The growth rates of each species
D. Whether the uptake of toxins can be improved by using fertilizers to accelerate growth

Question 25

The graph below shows lifetime carbon emissions from an average large electric vehicle and a comparable petrol vehicle as a function of distance travelled.

Lifetime carbon emissions for electric vehicle (EV) and petrol vehicle



Data derived from Gimbert, Y. (2020). *How clean are electric cars?* [online] Campaigning for cleaner transport in Europe | Transport & Environment. Available at: https://www.transportenvironment.org/discover/how-clean-are-electric-cars/.

Which statement comparing the emissions from electric vehicles (EV) to petrol vehicles is supported by the data in the graph?

A. EV cars are likely to produce less emissions in the first year of use.
B. EV cars have lower emissions associated with their manufacture.
C. EV cars have lower emissions associated with their use over their lifetime.
D. EV cars produce half as many emissions after 150,000 kilometres travelled.

Question 26

When conducting an investigation, you may need to use many specialised techniques and instruments. Some of these will produce qualitative results and others will produce quantitative results. Which technique below will result in qualitative data?

A. Using quadrats to calculate population density
B. Using a transect to identify species within a community
C. Using a microscope to count bacterial colonies from a polluted dam
D. Using a pH meter to determine the acidity or otherwise of a watercourse

Question 27

VCE Environmental Science students completed an experiment and recorded the following values after six trials:

5.12	5.17	5.13	5.14	5.13	5.15

The expected value for their experiment was between 7 and 8. The results obtained could be described as

A. accurate and precise.
B. accurate but not precise.
C. precise but not accurate.
D. neither accurate nor precise.

Question 28

How might the VCE Environmental Science students increase the validity of their experimental results?

A. By repeating the experiment in different conditions
B. By repeating the experiment
C. By using different scales to measure during the experiment
D. By using beakers to measure volumes of liquids

Question 29

The main difference between primary data and secondary data is that

A. primary data is collected by primary school students and secondary data is collected by secondary school students.
B. primary data is collected by someone else in different studies, surveys or experiments, while secondary data is data collected by the investigator undertaking the experiment or fieldwork.
C. secondary data is collected by someone else in different studies, surveys or experiments, while primary data is data collected by the investigator undertaking the experiment or fieldwork.
D. primary data is quantitative whereas secondary data is qualitative.

Question 30

A student was using quadrats to investigate the species diversity of plants in a 1 hectare area within a local forest. They sampled approximately 15% of the area. Some parts of the site were difficult to access and so they did not put quadrats in these parts.

An issue with the student's investigation is that

A. they did not minimise bias.
B. they used an inappropriate sampling method.
C. they did not use enough quadrats.
D. the area of forest is too small.

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 (16 marks)

A team of scientists have collected data to determine the impact of fires on biodiversity over the last twenty years in an area in Gippsland. The team used a combination of quadrat sampling and mark and recapture techniques to monitor fauna and flora species diversity. The Simpson's Index of Diversity (D) was compared at one site between two time points, with the site having experienced recurring fires and subsequent restoration.

The index (D) can be calculated using the following formula.

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

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

Calculations using this formula should produce a value between 0.1 and 1. A higher index value (that is, a number closer to 1) indicates higher species diversity.

a. Calculate Simpson's Index of Diversity (D) for the site after habitat restoration in the blank spaces in the table below. The index value before habitat restoration has already been calculated.

3 marks

Correct calculation of

$\sum [n_i (n_i-1)]$ [1]

N(N-1) [1]

D [1]

	Before habitat restoration (after fire)				After habitat restoration		
Species	**n_i**	**n_i -1**	**$n_i (n_i - 1)$**		**n_i**	**n_i -1**	**$n_i (n_i - 1)$**
Southern Barred Frog	18	17	306		32	31	992
Long-footed Potoroo	8	7	56		0	0	0
Southern Brown Bandicoot	5	4	20		18	17	306
Glossy Black Cockatoo	8	7	56		15	14	210
Ground Parrot	7	6	42		20	19	380
Lace Monitor	2	1	2		5	4	20
Swamp Skink	0	0	0		4	3	12
Eucalyptus trees	2	1	2		16	15	240
Banksia bushes	32	31	992		48	47	2256
Grevillea bushes	25	24	600		42	41	1722
N =	107		$\sum [n_i (n_i-1)]$ = 2076	N =	200		$\sum [n_i (n_i-1)]$ = 6138
N(N-1) =	11342			N(N-1) =	39800		
		D =	$1 - \frac{2076}{11342}$			D =	$1 - \frac{6138}{39800}$
		D =	1 – 0.183 = 0.817			D =	1 – 0.154 = 0.846

b. The scientists want to determine if the methods used to restore the burnt ecosystem have been successful or if changes should be made to the processes. Using the data, evaluate the impact of the current restoration process on species richness and species diversity at this site.

4 marks

Compare species richness before and after restoration (using data) - richness remained the same at 9 species [1]

Compare species diversity before and after restoration (using data) - before 0.817 after 0.846. The species diversity increased. [1]

Analysis of the restoration and statement of overall success [2]

- Students could determine that successful due to increase in species diversity as a result of population numbers increasing for most species and addition of swamp skinks OR
- Students could determine that unsuccessful due to the loss of the long-footed potoroo population (must still acknowledge that the species diversity has increased overall).

c. To collect the data, a combination of quadrat sampling and mark and recapture was used. Compare these two techniques and identify examples of species from the table for which each technique would be utilised.

3 marks

Brief description of the two techniques [1]

Identify key differences between the two techniques [1]

Identify examples of species that would be applicable for each technique [1]

d. The scientists are concerned about the Long-footed Potoroo, which is an endangered marsupial endemic to the area. Explain why the scientists are particularly concerned, and suggest one possible management strategy that could be implemented to support population growth of this species.

3 marks

Identifying the following key information.

- Before restoration 8 long-footed potoroos were recorded but none were recorded after restoration [1]
- As the species is classified as endangered and facing a very high risk of extinction in the wild in the near future any decrease in the population can have significant impacts on species survival [1]
- scientists should explore the use of a suitable option for increasing the number in the area such as translocation, captive breeding, or reintroduction. [1]

e. As is common with many endangered species, the genetic diversity of Long-footed Potoroo populations is of concern. Define genetic diversity and give two reasons why genetic diversity is important for the survival of a species.

3 marks

Genetic diversity definition (must relate to genetic diversity of species) [1]

For example – the variety and combination of genes within a population of a species

Two reasons why genetic diversity is important [2]

For example -

- Populations with low genetic diversity have a low capacity to adapt to changes such as environmental change or introduction of disease.
- Populations with low genetic diversity have an increased chance of inbreeding and maintaining deleterious alleles in the population.
- Populations with low genetic diversity have decreased reproductive fitness.
- Greater genetic diversity increases species survival and ability to adapt to changes.

Question 2 (13 marks)

Lake Pedder in Southwest Tasmania was a small lake in a national park. In 1972 the state government gave approval to build three dams to control the outflow from the lake in order to produce electricity. As a consequence of the damming, the lake was massively increased in size to become Tasmania's second largest water body with a very different ecology. A number of endemic species became extinct as a result of the flooding. There is a campaign to restore the original Lake Pedder and surrounding iconic ecosystems.

At the time the Hydro-Electric commission listed the following benefits of the proposal.

- Easier access to the Lake for tourists
- A larger lake with greater scenic appeal and capacity for tourists
- Construction jobs in the building of the dams
- Increase in electrical output for state's heavy industry

They also believed that while there were alternatives to the flooding of the area, the cost would be too great and wouldn't retain Lake Pedder in its natural state.

a. Identify and define the value system represented by these statements.

2 marks

Anthropocentrism [1]
Definition [1]
For example - humankind is the most important element of existence

b. Identify and describe a contrasting value system to the one described above and suggest a statement that could be made in opposition or support of the damming of Lake Pedder which is consistent with this system.

3 marks

If the student answered anthropocentrism for part a, they must use ecocentrism, biocentrism or technocentrism.
If the student did not answer anthropocentrism for part a, a different and contrasting value system to what they stated in part a must be used to gain full marks.

Name of contrasting value system [1]
Definition of contrasting value system [1]
Statement consistent with the stated value system [1]

For example

- Biocentric- all living things have the right to exist. The damming of the Lake is inconsistent with this value as species could/did go extinct
- Ecocentric-the ecosphere is of central importance. The damming of the lake will result in large changes to the ecosphere, changing the biosphere and hydrosphere in particular so should be avoided.
- Technocentric-technology can control and protect the environment. The damming of the lake could use technologies to reduce the harm caused to the environment such as a monitoring water quality and adjusting inflows and outflows to protect the environment.

- (Anthropocentric - humankind is the most important element of existence. The dam should go ahead because there are more benefits to humans.)

The "Restore Lake Pedder" movement is in the process of developing a Restoration Management Plan for the removal of dams and restoration of ecosystems.

c. Identify two stakeholders the movement should engage with to understand possible objections and concerns related to the restoration. Include what the stakeholder's objections or concerns could be.

2 marks

Any two reasonable responses [1 mark each]

For example

- Hydro Employees- worried about job losses.
- Green supporters- worried about reduction in renewable energy/impact of removal
- Tourist operators- worried about reduction in lake volume/amenity/business
- Politicians- worried about electoral response to proposal
- Ecologists – worried about loss of species that are adapted to the larger lake

The ecological restoration plan identifies a number of risks of harm from the rehabilitation process. These include:

- the speed and way in which the water is drained from the lake
- sediment being carried downstream and impacting ecosystems
- the movement of pests/weeds.

d. Given the risks identified suggest one action that could be taken to reduce the potential harm.

1mark

Any reasonable and scenario suitable response [1]

For example

- sediment traps/filters
- release water slowly over time
- measures to monitor and eradicate pests/weeds
- planting desired species to outcompete weed species

e. Outline how identification and management of these risks links to the precautionary principle?

3 marks

Process to identify and assess the consequences and likelihood of harm being caused [1] And consider how to reduce risks to a level acceptable by stakeholders/propose mitigation strategies/monitoring etc [1]. If the risk is deemed too high and there is insufficient certainty then the precautionary principle would stop the restoration plan [1]

Supporters of "Restore Lake Pedder" are inspired by the positive impact of the removal of a 1964 dam at the Lagoon of Islands in 2013. Ten years later the recovery has moved to a monitoring phase as the wetland ecology is in a relatively healthy state.

f. Give two examples of how such a restoration fits with the sustainability principle of conservation of biodiversity and ecological integrity.

2marks

Any two distinct and relevant points [1 mark each]
For example

- The Dam changed the original wetland ecosystem and the restoration brings back the ecological integrity to something approaching the original
- The ecosystems that have developed from the flooding will be lost when the dam is emptied.
- Removing the Dam will not bring back the original wetlands as many organisms were lost/extinct

Question 3 (11 marks)
The North East Link Program (NELP) is being built by the Victorian Government and represents the 'missing link' in Melbourne's transport network. The project will connect the M80 with the Eastern Freeway via 6.5 km of three-lane tunnels in conjunction with upgrading existing freeways, adding, or upgrading cycling and walking paths, and improving community facilities. Once completed there will be a reduction of 15,000 trucks on local roads each day and travel time will be reduced by 35 minutes. The tunnels will be tolled, requiring payment for each section of a nominated trip.

In the early stages of development, a large amount of backfill material is required. The construction will use 100% recycled material that acts as a stabilised sand. This sustainable material has an additional benefit for driver safety in the wet due to its enhanced moisture controlling abilities.

a. The design and construction company has focused on sustainability and incorporated circular economy thinking as a key component of the NELP design. Compare the aim of circular economy thinking with the more traditional linear economy approach, including an advantage of moving to circular economy thinking in this scenario.

4 marks

Description of circular economy thinking [1]
For example
- Using renewable sources that are collected and reused
- Materials and products are reused, recycled and repaired
- Not using of raw products
- Make, Use, Collect, Transport, Reuse

Comparison to linear economy [1]
For example
- Linear economy resources are raw/natural resources extracted from the environment
- Products end up in landfill
- Take, Make, Use, Dispose

Advantage of circular economy [1] with reference to this scenario [1]
For example
- Reusing recycled material and making it into the new stabilised sand. This ensures the material being recycled does not end up as waste in landfill or/ no new resources are required to make the backfill which would have to be extracted from the lithosphere (saving raw material).

In addition to the moisture control characteristics of the new stabilised sand material used in the backfill process, the company has noted that due to the well characterised and standardised structure, less testing of the backfill has been required. The new backfill has also been transported more efficiently than the usual material used in such projects resulting in fewer truck trips to the site and less road disruptions.

b. One of the tools for integrated sustainability assessment is a cost-benefit analysis. Referring to the information above, analyse the costs associated with the use of the recycled material and determine whether this is contributing to the NELP being a sustainable development.

3 marks

Describe cost-benefit analysis [1]
Provide specific example of cost-benefit of using the recycled material [1]
For example
- Reduction in transport costs for the organisation due to reduced trips
- Reduction in costs associated with using a recycled material instead of buying new backfill

- Reduction in testing costs due to nature of the material

Link to sustainable development of NELP [1]

For example

- Sustainable development as can link to economic benefits and environmental benefits. If consider the reduction in truck on the roads will also allow community to move quicker through this area so their time and costs are not increased (sociocultural)

The decision to build a significant portion of the project as tunnels was made to avoid impacts on the Yarra River corridor. The area that the North East Link will cover includes a floodplain and parkland that has significant ecological value, and provides a secluded, natural environment that is highly valued and enjoyed by local communities and visitors across Melbourne. A number of areas have been declared no-go zones for the project with clear instructions provided that these areas are not to be negatively impacted. This includes the Bolin Bolin Billabong, Grey-headed flying fox campsite within Yarra Bend Park, and the Plains Grassy Woodland community in Bundoora. There are also other threatened and non-threatened native fauna and flora including six threatened aquatic species.

c. Identify the possible impacts the redevelopment and construction of the new infrastructure could have on Earth's four systems (these impacts could be viewed as positive or negative).

4 marks

State the name of the system (hydrosphere, biosphere, lithosphere and atmosphere) and give reasonable impact related to the scenario [1 mark each]

For example

- Hydrosphere: Not impacting the normal flow and processes of the Yarra River and taking into account the flood plain
- Biosphere: Although the tunnels will impact some of habitat and the flora and fauna in the area, the negotiation of no-go areas reduces the impact on threatened species and their habitats.
- Lithosphere: there will be considerable disruption to the soil with the incorporation of 6.5 km tunnels and the infrastructure required to support these tunnels.
- Atmosphere: there will be a reduction in the number of trucks using the current roads and the travel times will be reduced by 35 minutes. This will reduce greenhouse gas emissions and the amount of fossil fuels used as people move across Melbourne

Question 4 (5 marks)

Scientists use a range of methods for understanding past atmospheres for comparison with that of today. No method is without error, so usually multiple sources of data are gathered. With these techniques, scientists understand what has been happening over the past millennia.

The graph below shows the levels of carbon dioxide (ppm) and Antarctic temperature (°C) from past millennia to present day.

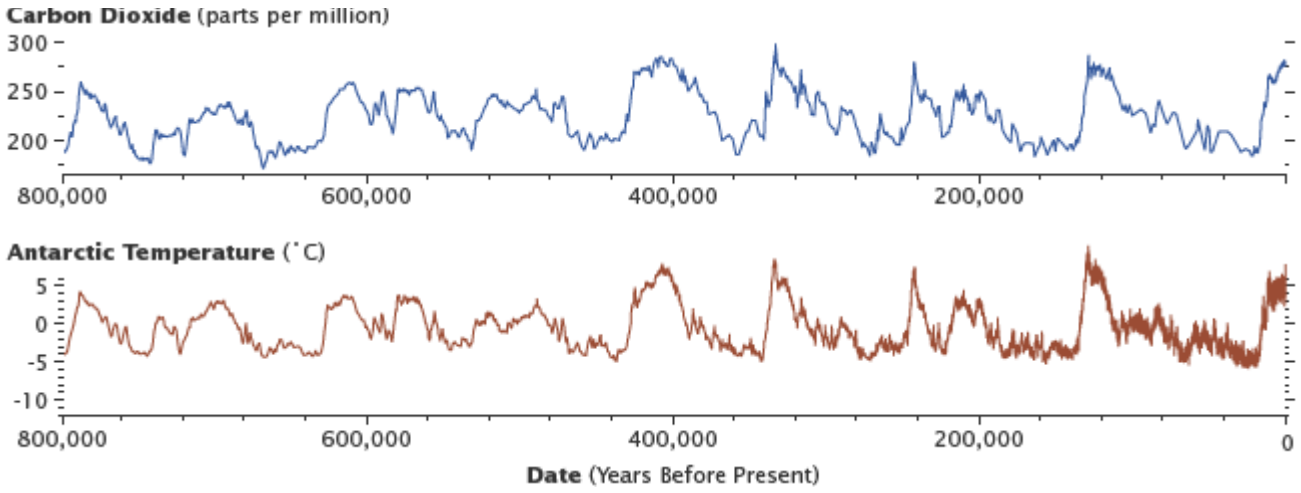


Image credit: Bvelevski, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons

a. State the correlation between carbon dioxide levels and Antarctic temperature. Justify your response.

2 marks

As the level of carbon dioxide increased (peak), or decreased (trough), so too did the Antarctic temperature [1]. Justification must be shown with reference to data from the graphs (this will be approximate) [1].

b. Ice-core sampling and paleoclimate records are two methods commonly used to measure past changes in the atmosphere. Describe and compare these two methods.

3 marks

Description of ice-core sampling [1] (for full marks must identify it is the substances trapped in the ice that are measured)

For example

- Ice-core samples are collected via cylinders of ice extracted from ice sheets or glaciers and reveal information about past temperatures and climatic conditions from atmospheric bubbles and/or particles trapped in the ice.

Description of paleoclimate records [1] (for full marks must include requirement of knowing preferred growing conditions)

For example

- Paleoclimate records is the use of plant fossils OR tree rings OR sedimentation at the bottom of lakes to determine pollen changes OR impressions of plant parts, to decipher the climatic and landscape conditions as long as the preferred conditions of the plant are known.

One clear comparison [1]

For example

- Ice cores can be used to directly measure past atmospheric conditions whereas paleoclimate records provide proxy data for atmospheric conditions.
- Ice core information is more specific.
- Difference in conditions required to preserve information – locations with ice compared to locations with suitable sedimentation/fossilisation conditions.

Question 5 (8 marks)

Refer to the following table to answer questions a. and b.

Attributes and concentrations of select greenhouse gases.

Gas	Average Preindustrial Concentration (ppb)	Approximate 2021 Concentration (ppb)	Atmospheric lifetime (years)
Carbon dioxide (CO_2)	280, 000	418, 000	300-1000
Methane (CH_4)	714	1,800	12
Nitrous oxide (N_2O)	275	327	120 - 150
Chlorofluorocarbons & halocarbons	0	1.2	100 – 150

[Parts per billion; 1,000 ppb = 1 part per million (ppm)]

a. Suggest two reasons why atmospheric concentrations of nitrous oxide have changed over time.

2 marks

The concentration has increased [1]
Two reasons [1] - For example
- Chemical manufacturing
- Fertiliser use
- Soil cultivation
- Catalytic converters in cars
- Growing leguminous crops
- Livestock manure
- Fossil fuel combustion

b. Methane is being released naturally as the Arctic tundra's permafrost melts due to changing climate and global warming. Provide an explanation as to why scientists are particularly concerned with the increase of this greenhouse gas in our atmosphere.

2 marks

Methane has a higher Global Warming Potential than carbon dioxide [1] and therefore it can absorb more infrared radiation and has a proportionally greater contribution to the enhanced greenhouse effect [1] OR
Methane has increased by at least 2.5 times since preindustrial times [1], whereas carbon dioxide has only increased by 1.4 times since preindustrial times [1].

c. Carbon sequestration is being increasingly utilised in an attempt to reduce the high levels of carbon dioxide in the atmosphere. Define carbon sequestration, describe how oceans sequester carbon, and identify an impact climate change is having on this process.

4 marks

Definition of carbon sequestration [1]
For example
- carbon dioxide is removed from the atmosphere and stored elsewhere

Description of how oceans absorb and store carbon [2]
For example
- carbon dioxide from the atmosphere dissolves in seawater
- carbon is incorporated into the shells of many aquatic organisms
- phytoplankton incorporates carbon through photosynthesis
- process of sedimentation stores carbon at ocean floor

Climate change impact [1]
- increasing water temperatures slow the process

Question 6 (7 marks)

The following graph shows satellite sea level observations for 1993 to the present.

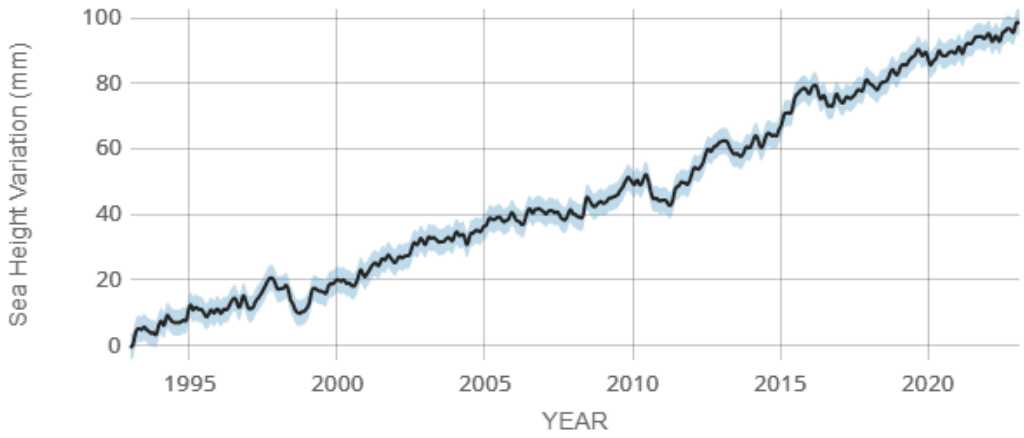


Image credit: National Aeronautics and Space Administration
https://sealevel.nasa.gov/understanding-sea-level/key-indicators/global-mean-sea-level

a. Sea level rise is caused primarily by two factors related to our warming Earth; state the two factors.

2 marks

Added water volume from melting icesheets and glaciers [1]
Expansion of seawater as it warms OR thermal expansion of seawater [1]

The analysis and reporting of climate data and the relevant climate projections come with a range of confidence measures, from very high to very low. For example, for a range of scenarios the IPCC states with *high confidence* that global average temperature will exceed 1.5 °C above pre-industrial temperatures, while it states with *medium confidence* that sea levels will rise between 0.43m and 0.84m by 2100.

b. Why are confidence levels in projections given, and what information is used to determine the confidence level?

3 marks

Climate predictions can never claim 100% certainty [1]
The IPCC established a degree of 'certainty' based on the quantity of evidence [1] and the level of agreement of the evidence between different scientists [1]

Therefore, according to the quantity of evidence and the agreement between different scientists, the IPCC have a 'high confidence' that the temperature will exceed 1.5°C compared to a 'lower' level of confidence in sea level rise.

c. Outline one way the Victorian government could use local climate projections.

2 marks

Statement of likely projection [1] and how projection can be used [1]
Range of reasonable responses possible
For example
- Use projections for sea level rise to limit development in coastal areas

- Use projections for decrease in rainfall to advise farmers on alternative crops
- Use projections for increased days of extreme heat to increase funding for planting of street trees

Question 7 (10 marks)

Electrify 2515 is an organisation that aims to create the world's first zero emissions community in the postcode of 2515 in NSW. They are creating a pilot project to investigate what it would take to electrify an entire suburb to support the bigger goal of electrifying the country. The electrification of homes and small businesses would mean:

- installing solar panels
- installing batteries to store electricity generated by the solar panels
- replacing gas powered water, cooking and heating with electric
- adopting electric vehicles.

a. Outline the energy conversions in a gas hot water service or gas heater in the home.

1 mark

Chemical →Thermal

An electric heat pump can be used to heat water or air. Heat pumps use a small amount of electrical energy, and the compression and expansion of a refrigerant to move heat from outside to inside. For every Joule of electrical energy supplied 3-6 Joules of heat energy are transferred.

b. Using your understanding of the laws of thermodynamics, explain whether heating using combustion of gas could ever be as efficient as using an electric heat pump.

3 marks

The transfer in a heat pump is moving heat as opposed to an energy conversion (chemical → thermal) in gas heating [1]

No energy conversion is 100% efficient (second law of thermodynamics) and therefore the efficiency of heating with gas will always be less than 100% [1] (the data above shows an efficiency of 300-600% for electric heat pumps)

Some of the heat in gas conversion is lost to the environment [1]

The table below outlines the key differences between three types of stovetops used for cooking.

	Electric Induction	Electric Resistance	Gas
Heating method	Electricity generates a variable magnetic field which induces a current in the cookware, resistance to the current generates heat	Resistance to movement of electricity through a coil generates heat	Combustion of flame
Heat Transfer	Pot heats up directly	Coil heats pot	Flame heats pot
Heating speed	Fast	Moderate	Moderate
Temperature Control	Precise	Moderate	Good
Safety	Warm surface	Hot surface	Open flame
Comparative Energy Efficiency	High	Moderate	Low

c. Explain what features described in the table are responsible for the higher efficiency of induction stovetops?

2 marks

Heat transfer [1]
Induction stoves directly heat up the pot reducing energy losses compared to the other methods described which indirectly heat up the pot and the contents and lose more heat to the room [1]

d. With reference to specific changes proposed by Electrify 2515, outline two ways a fully electric suburb could reduce greenhouse gas emissions.

4 marks

Range of reasonable responses possible however full marks can only be given for explaining how the reduction of emissions occurs as a result of changes mentioned in the scenario (installing solar panels, installing batteries, replacing gas appliances with electric, adopting electric vehicle).

For example

- The installation of solar panels with battery storage will reduce carbon emission as the suburb will no longer be reliant on fossil fuel generated grid electricity [1]. The combustion of fossil fuels to generate electricity emits carbon dioxide. [1]
- As electric vehicles do not require fuel [1], replacing petrol vehicles with electric vehicles will eliminate the emissions of carbon dioxide, methane and nitrous oxides from transportation [1].

Question 8 (7 marks)

Replacing the use of petrol and diesel in transport is a high priority for any country looking to reduce emissions.

Biofuels are an alternative fuel source to power cars and trucks. The demand in Europe for biofuels has grown significantly over the last ten years. As an example, the production of biodiesel from vegetable oils, such as palm oil and soy, accounts for half of the imports of palm oil into Europe from countries such as Indonesia and Malaysia

a. Explain how biofuels could be considered carbon neutral.

2 marks

Biofuels use the energy from the sun, carbon dioxide and water to produce oils and when combusted produces carbon dioxide and water. [1] If the amount of carbon dioxide produced is equivalent to the amount fixed by photosynthesis than it can be considered carbon neutral [1]

b. The increase in demand for biofuels has led to some situations where biodiesel has higher carbon emissions that the diesel it is supposed to replace. Use Earth Systems thinking to explain how it is possible for biodiesel to have higher carbon emissions than standard diesel.

3 marks

Range of reasonable responses possible. Response should include:
Clear detail of interactions between systems [1]
Impact on the carbon cycle [1]
Consequences for carbon emissions [1]

For example

- Establishment of crops for biofuels can lead to deforestation and land use change
- Alteration may reduce the capacity of the lithosphere/biosphere to sequester carbon
- Carbon is released from disturbed soil
- Use of machinery and fertilizers emit carbon
- Crops sequester less carbon than equivalent area of forest

As a consequence, when biodiesel is used the net emissions can be higher than when the carbon is released through the production and use of diesel, which predominantly is carbon movement from lithosphere to atmosphere.

c. Suggest two regulations a government could implement to reduce the likelihood of creating biofuels with higher carbon emissions than petrol and diesel.

2 marks

Range of reasonable responses possible. At least two suggestions required.

For example

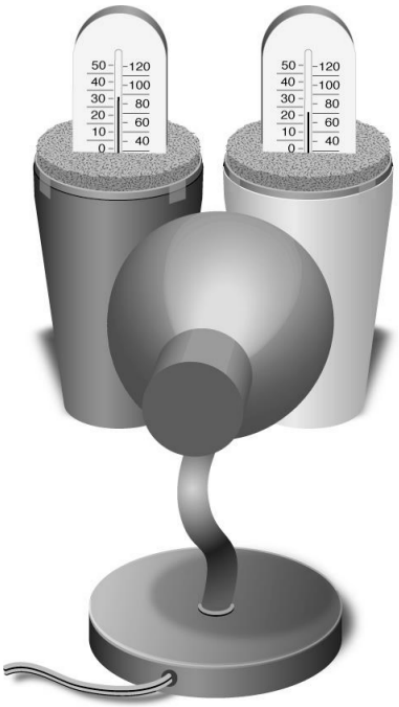
- limiting the contribution of biofuel in energy mix
- emission standards that include the source of biofuels
- requiring the use of biomass waste or non-food sources rather than food-based biofuels
- increase regulation of land use change
- incentivise offsets such as afforestation

Question 9 (13 marks)

A group of Environmental Science students conducted an investigation to confirm that a dark coloured surface absorbs more energy than a light coloured surface, as indicated by the differences in the final readings of two thermometers.

Below is an outline of the procedure undertaken to set up the investigation:

1. Two containers were placed on a level surface and the air inside the containers was allowed to stabilise with the ambient air in the room.
2. While waiting for the temperatures to stabilise, a strip of black paper and white paper were cut to fit the containers. Each sheet of paper was taped around the outside of the containers, making sure the whole surface was covered.
3. Two pieces of foam were cut to firmly fit like caps inside the top of each container.
4. Slots were cut in each foam cap for inserting the thermometers (to create a snug fit). One thermometer was placed inside the slot of each foam cap. The caps with the thermometers were inserted firmly on each container, making sure that the liquid in the thermometer was visible.
5. The initial, stabilised temperature of each thermometer was recorded.
6. The two containers were placed side by side and a heat lamp was placed about 15 cm from the containers and turned on.
7. The temperature of both thermometers was recorded at 1-minute intervals, for a total of 10 minutes.
8. The completed setup for conducting the experiment is shown below.



Adapted from: Exline, JD., Levine, AS. and Levine, JS. 2006, Meteorology: An Educator's Resource for Inquiry-Based Learning for Grades 5-9. National Aeronautics and Space Administration, <https://www.nasa.gov/centers/langley/science/met-guide.html>

a. Identify the independent variable for this investigation.

1 mark

Different colour container (dark/black AND light/white)

b. Identify the dependent variable for this investigation.

1 mark

Change in temperature (°C)

The student group obtained the data shown in the following table.

Results: Surface colour and the effect on temperature change

Time (mins)	0	1	2	3	4	5	6	7	8	9	10	Temp. change
Black (°C)	22	22	24	25	26	27	29	31	33	34	35	13
White (°C)	22	22	23	23	24	24	24	27	27	27	28	6

c. Calculate the temperature change for 'black' and 'white' to complete the last column in the results table.

2 marks

Refer to table above

d. Graph the results on the following grid-lines.

5 marks

Title: 'Surface colour absorption of energy vs temperature change (°C)' (or similar) [1]

Line graph with accurately plotted points for each line showing black and white colour temperature [2]

y-axis temperature (°C), and at correct scale [1]

x-axis time (min) in 1 minute intervals and ending at 10 mins, and at correct scale [1]

e. State the name of the natural phenomenon this investigation was aiming to replicate.

1 mark

The albedo effect [1]

f. A student group formulted the following hypothesis before undertaking this investigation:

‘If a container with a black surface is exposed to a heat lamp for 10 minutes it will record the greatest temperature change compared to a container with a white surface because the black surface will absorb more of the incident radiation’.

Does the data provided in the results table support or refute the student group’s hypothesis? Justify your response and explain the results.

3 marks

The data provided supports the student group’s hypothesis [1].
The temperature of the white container increased 7 degrees more than the black container (data must be used to justify) [1]
This is because black surfaces become warmer because they absorb more of the incident radiation OR white surfaces reflect more of the incident radiation, hence absorb less radiation [1]

END OF QUESTION AND ANSWER BOOKLET

ENVIRONMENT EDUCATION VICTORIA

Victorian Certificate of Education 2023

Environmental Science

STUDENT NUMBER: ____ ____ - ____ ____ ____ - ____ ____ ____ - ____

STUDENT NAME: _____ CLASS: _____

Trial Written 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