Neap

VCE Environmental Science Units 3&4

Suggested Solutions

2024 Trial Examination

Section A – Multiple-choice questions

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

Question 1 B

B is correct. As weeds spread, they act as competitors for native species in terms of both space and nutrients. This puts pressure on native populations, therefore impacting biodiversity.

A is incorrect. The spreading of weeds may create new habitats for animal species; however, this would not be a direct threat to biodiversity.

C is incorrect. Limited space for breeding does not increase inbreeding.

D is incorrect. Biomagnification refers to an increase in toxin concentrations in a food chain; it is not caused by soil erosion.

Question 2 C

C is correct. One way to measure a species' genetic diversity is through its DNA, which is shown in its genes and alleles.

A is incorrect. This option describes how to measure the genetic diversity of all species on Earth.

B and **D** are incorrect. Relative abundance does not relate to genetic diversity.

Question 3 D

D is correct. Supporting services are those that support and maintain life; they include processes such as nutrient cycling and photosynthesis. Regulating ecosystem services are those that regulate the health of ecosystems; they include pollination, carbon storage and decomposition.

A and **B** are incorrect. Supporting and regulating services are equally important and occur in both marine and terrestrial environments.

C is incorrect. The provision of food and medicine are provisioning services, not supporting services.

Question 4 C

C is correct. Recent biodiversity loss has been accelerated by anthropogenic factors. To provide evidence of this, a baseline rate of extinction is needed as a comparison. Background extinction data provides this baseline.

A is incorrect. Background extinction rates are numerical values; therefore, they can only provide quantitative data.

B is incorrect. Individual species cannot be assigned risk values by looking at background extinction rates.

D is incorrect. Background extinction rates are not specific to mass extinctions.

Question 5 A

A is correct. Background extinction is the standard extinction rate that occurs without human intervention. It can be calculated in the geological past by identifying different species and their appearance and disappearance in the fossil record.

B, **C** and **D** are incorrect. Past atmospheric conditions, current diversity and a loss of species from only one mass extinction would not identify the number of species appearing and disappearing in the geological past.

Question 6 B

B is correct and **A** is incorrect. The *Flora and Fauna Guarantee Act 1988* (Vic) provides legal protection to the spotted-tail quoll in all of Victoria only.

C is incorrect. The legal responsibility for the spotted-tail quoll's protection is not solely that of the Eastern Maar people.

D is incorrect. Although the spotted-tail quoll is protected, there are no specific changes in tourism specified by the *Flora and Fauna Guarantee Act 1988* (Vic).

Question 7 A

A is correct. Critically endangered is a higher conservation category than endangered.

B, **C** and **D** are incorrect. These options are lower conservation categories than 'endangered' and would therefore represent an increase in population numbers.

Question 8 C

C is correct. Intergenerational equity considers the benefits and uses of a natural space for both the current and future generations.

A is incorrect. The user pays principle considers monetary exchange for the use of a space or service.

B is incorrect. Intragenerational equity considers the current generation only.

D is incorrect. Efficiency of resource use considers the minimisation of waste.

Question 9 A

A is correct. The precautionary principle is triggered when a project does not provide sufficient evidence that the environment will be safe from harm. In this case, the mining company has not provided sufficient proof that the Tasmanian masked owl would be safe from harm during or after the construction of the tailings dam.

B is incorrect. The type of ecosystem is not relevant to the precautionary principle.

C is incorrect. The type of construction is not relevant to the precautionary principle.

D is incorrect. Stakeholder involvement does not necessarily trigger the precautionary principle.

Question 10 B

B is correct. Anthropocentrism is a value system centred on the benefits that the environment can provide to humans. In this case, the mining company is seeking financial gain.

A and **C** are incorrect. Biocentrism and ecocentrism are both value systems that are centred on the protection and maintenance of the natural environment.

D is incorrect. Sociocultural is a dimension of sustainable development, not a value system.

Question 11 C

C is correct. Leakage of heavy metals and toxic waste into rivers causes harm to the hydrosphere. Leakage of heavy metals and toxic waste into soil causes harm to the lithosphere. The hydrosphere and lithosphere are both systems that contain life, thus also inferring harm caused to the biosphere.

A, **B** and **D** are incorrect. The question does not indicate any harm caused to Earth's atmosphere.

Question 12 D

D is correct. Balancing water usage supports agricultural practices long-term, which provides economic benefits to communities through food sales.

A is incorrect. Limiting the amount of water available for agriculture is a potential economic cost, not a benefit.

B is incorrect. Ecosystem health is an environmental benefit, but not a direct economic benefit.

C is incorrect. Improved recreation is a sociocultural benefit, but not a direct economic benefit.

Question 13 C

C is correct. Circular economy thinking aims to reduce waste by using the waste (output) of one product as the material (input) to create a new product.

A is incorrect. Circular economy thinking does not require consumers to be paid.

B is incorrect. Circular economy thinking is not the same as recycling. While recycling involves the conversion of waste, circular economy thinking aims to avoid creating waste in the first place.

D is incorrect. Many types of materials can be used in a circular economy scheme.

Question 14 C

C is correct. In the enhanced greenhouse effect, greenhouse gases in the troposphere absorb infrared radiation before re-emitting it, keeping the heat in the atmosphere for longer.

A is incorrect. Ultraviolet radiation is absorbed in the stratosphere and does not impact global temperatures.

B is incorrect. Visible light continuously reaches Earth; it is not absorbed by greenhouse gases.

D is incorrect. The albedo effect does not increase ocean temperatures; it is a measurement of surface reflectivity.

Question 15 D

D is correct. Increased carbon emissions from fossil fuel combustion is the greatest contributor to global temperature increases.

A is incorrect. Loss of shade from deforestation would not impact global temperatures in the long term.

B is incorrect. Increased evaporation has caused an increase in water vapour in the atmosphere.

C is incorrect. Although livestock agriculture has caused methane emissions to increase, this is not the greatest contributor to global temperature increases.

Question 16 A

A is correct. The graph shows an average trend of increasing temperature anomalies from the year 2000, which indicates increasing global temperatures.

B is incorrect. The bars below the 0.00 line indicate lower than average temperatures for that particular year. An ice age is a long-term severe reduction in temperature.

C is incorrect. Long-term data is important in climate science.

D is incorrect. The graph shows that 1940 and 1980 temperatures were approximately equal to the baseline average temperature between 1951 and 1980 that the graph data is measured against.

Question 17 D

D is correct. Greenhouse gas warming potential is a measurement of the amount of energy that 1 tonne of a named gas absorbs compared to 1 tonne of carbon dioxide. So, if sulfur hexafluoride has a greenhouse gas warming potential of 23 500, then 1 tonne of sulfur hexafluoride will absorb 23 500 times more energy than 1 tonne of carbon dioxide.

A and **B** are incorrect. These options compare the energy absorption of nitrous oxide with sulfur hexafluoride, not carbon dioxide.

C is incorrect. 1 tonne of nitrous oxide absorbs 265 times more energy than 1 tonne of carbon dioxide.

Question 18 B

B is correct. Circulating ocean currents send cold water from the poles to the equator where is it warmed. As the warmed water is less dense than the cold water, it rises to the surface.

A is incorrect. Water is warmed at the equator, not cooled.

C and **D** are incorrect. Ocean currents are continuously circulating and do not discontinue movement.

Question 19 C

C is correct. Large-scale algae farms allow for biological carbon sequestration, therefore reducing atmospheric CO_2 levels.

A is incorrect. Electric vehicles are not living and therefore are not considered biological technology.

B is incorrect. Carbon capture and storage is a method of geological carbon sequestration.

D is incorrect. Ethanol production does not reduce atmospheric CO_2 levels.

Question 20 B

B is correct. Climate projections are based on data collected from multiple atmospheric and oceanic components. The more data that is collected, the more accurate predictions are likely to be. Therefore, collecting multiple pieces of data over multiple years leads to higher confidence in projections.

A is incorrect. A single year is not long enough to make confident projections.

C and **D** are incorrect. A single piece of data is not enough to make confident projections.

Question 21 B

The graph shows that 13% of Victoria's electricity was produced using solar energy.

Dividing the percentage of solar energy by 100 and multiplying by the electricity consumed gives:

$$\frac{13}{100} \times 95 = 12.35$$

Question 22 B

B is correct. A reduction in the cost of solar photovoltaic panels may encourage more Victorians to use solar energy to produce electricity at home. This would decrease reliance on the grid electricity that is produced by burning brown coal.

A is incorrect. Importing more electric vehicles will not directly impact reliance on brown coal, as brown coal is used in the production of electricity needed to power electric vehicles.

C is incorrect. An increase in funding allocated to the mining sector would likely increase the extraction of brown coal.

D is incorrect. A reduction in wind turbines may increase reliance on brown coal.

Question 23 B

The first law of thermodynamics states that energy can neither be created nor destroyed, it can only be converted from one form to another.

Question 24 B

B is correct. Biofuels are derived from biomass, which is biological matter that has not become fossilised. Biofuels are a renewable resource, as the biomass used to produce biofuels are able to be replenished within a human lifetime.

A, C and **D** are incorrect. These options do not identify the resources needed to produce biofuel.

Question 25 D

Subtracting the initial value of methane emissions in 2000 from the final value of methane emissions in 2022 gives:

$36.7 - 21.3 = 15.4$

Dividing the difference in methane emissions by the initial value gives:

$$\frac{15.4}{21.3} = 0.723$$

Multiplying this value by 100 to find the percentage increase gives:

$0.723 \times 100 = 72\%$

Question 26 D

D is correct. Gravitational potential energy is not involved in the process of producing electricity from uranium (nuclear energy).

A is incorrect. Kinetic thermal energy produces steam in a nuclear reactor.

B is incorrect. Kinetic mechanical energy moves the turbines in a nuclear reactor.

C is incorrect. Uranium has nuclear potential energy prior to nuclear fission occurring.

Question 27 C

C is correct. All four pots were filled with 4.5 litres of soil. As this was kept constant throughout the experiment, it is a controlled variable.

A and **D** are incorrect. The mass of each pot after 14 days is a variable that changes depending on the hydrogel ingredients. Thus, it is a dependent variable.

B is incorrect. The type of hydrogel is the independent variable.

Question 28 A

A is correct. Systematic errors occur when the measuring equipment used is consistently inaccurate. In this case, uncalibrated scales would lead to inaccurate values being recorded each time a pot was weighed.

B, **C** and **D** are incorrect. These options are examples of random errors.

Question 29 C

C is correct. Multiple controlled variables allow for improved validity, as they would help to ensure that the independent variable is the only factor impacting the dependent variable.

A is incorrect. Collecting data over 14 days may improve precision but would not necessarily have improved validity.

B is incorrect. Using a number of independent variables or experimental groups may provide accurate data but does not necessarily improve the validity of the data.

D is incorrect. Multiple trials improve repeatability and precision but do not necessarily improve validity.

Question 30 A

A is correct. Responsible disposal of chemicals ensures that no unnecessary environmental harm occurs from the experiment, therefore meeting ethical guidelines.

B and **C** are incorrect. These options describe safety guidelines, not ethical considerations.

D is incorrect. Although important when considering bias, it is not necessary to report measurement uncertainty in order to meet ethical guidelines.

Section B

Question 1 (12 marks)

a. Relative abundance refers to the evenness of the distribution of species between ecosystems. 1 mark

Simpson's Index of Diversity (SID) values increase when relative abundance is higher or more even across different species. 1 mark

b. *For example:*

The increase in species richness means that the total number of species has increased since the area became a marine sanctuary. 1 mark

The increase in SID value indicates that species diversity has increased overall since the area became a marine sanctuary. 1 mark

This implies that the marine sanctuary has been successful in improving biodiversity. 1 mark

1 mark for linking the increase in species richness to the increase in the total number of species.
1 mark for linking the increase in SID value to increased species diversity.
1 mark for concluding that the marine sanctuary has been successful in improving biodiversity.

c. **i.** quadrat 1 mark

ii. A quadrat could be placed randomly or at 1-metre increments along the transect line, 1 mark
allowing sampling to be taken from a uniform space and regular increments. 1 mark

iii. Rocky reefs usually display zonation/different linear habitats. 1 mark
Therefore, the transect line allows the people conducting the study to see a linear pattern in the biodiversity of the area and changes in zones or habitats along the transect line. 1 mark

d. *For example, any one of:*

- High levels of human recreation can impact species, so gathering data on the type of recreation in the area can provide a more accurate representation of how biodiversity has been impacted after the area was declared a marine sanctuary.
- Human recreation could affect the outcome of the study because it's an extraneous variable.

2 marks

1 mark for explaining why data on human recreational activities is important to collect.
1 mark for linking to the study of Eagle Rock Marine Sanctuary.

Question 2 (11 marks)

a. Fire promotes the sprouting/germination of the Wrinkled Buttons. 1 mark

If fires are inconsistent or do not occur often enough, the Wrinkled Buttons may not have the opportunity to resprout, which would lower population numbers. 1 mark

b. *For example, any one of:*

- Reduced genetic diversity may leave the Wrinkled Buttons vulnerable to rapid environmental changes or pressures.
- Low numbers of individuals may mean that pollination is difficult, which may impact the Wrinkled Buttons' ability to reproduce.

2 marks

1 mark for identifying one reason that low population numbers could threaten the Wrinkled Buttons.

1 mark for explaining how low population numbers threaten the Wrinkled Buttons.

c. The Wrinkled Buttons is endemic to a particular area of the Victorian coastline, meaning that it is found only there and nowhere else in the world. 1 mark

Endemic species require high levels of conservation because their populations are restricted and therefore vulnerable. 1 mark

d. The acquisition of thorough baseline population data provides conservationists with accurate locations and population numbers of the plant **OR** baseline data to compare populations against, 1 mark
so that they can work to minimise threats in all locations that the Wrinkled Buttons is found. 1 mark

e. Seeds can be planted in the future to grow more Wrinkled Buttons 1 mark
with chosen genetics, which will help to improve population resilience. 1 mark

Note: Responses may also refer to improvements to genetic diversity and wild population numbers.

f. The Scientific Advisory Committee of the *Flora and Fauna Guarantee Act 1988* (Vic) has evaluated the species population of the Wrinkled Buttons; however, the IUCN has not. 1 mark

Question 3 (14 marks)

a. *For example:*

This project should not be approved. This project requires high volumes of water to be taken from an aquifer, which will place the natural river system even further at risk of low pH levels and increased loss of species. The native species of the region may suffer from the construction of the park, as well as the increased light, noise and traffic pollution during and after construction. Therefore, the project does not uphold the sustainability principle of conservation of biodiversity and ecological integrity, which states the importance of an ecosystem to maintain its functioning, species diversity and species abundance, including the capacity for self-renewal.

If the project is rejected, the aquifer would be able to naturally replenish the water, and the river system will have the opportunity to return to its natural state, providing benefits to the hydrosphere and the local biodiversity of the area.

3 marks

1 mark for stating that the project should not be approved with reference to how the project will affect the surrounding ecosystem.
1 mark for explaining that the project does not uphold the principle of conservation of biodiversity and ecological integrity.
1 mark for explaining how rejecting the project will help to meet the principle of conservation of biodiversity and ecological integrity.

b. *For example:*

A qualitative risk analysis is used to decide whether to approve a project and to make decisions about the project if it is approved. If the project is approved, a qualitative risk analysis should be used to assess any sociocultural and environmental hazards that may be present. As part of the analysis, potential hazards are identified and the likelihood of each hazard occurring is placed on a scale from ‘rare’ to ‘almost certain’. Each hazard is then subjectively rated on severity from ‘negligible’ to ‘catastrophic’.

3 marks

1 mark for stating the purpose of a qualitative risk analysis.
1 mark for describing how a qualitative risk analysis assesses the likelihood of potential hazards.
1 mark for describing how a qualitative risk analysis assesses the severity of potential hazards.

c. *For example, any one of:*

- Clearing land for the park and dome removes space for the people in the town to use recreationally.
- Using the water from the aquifer could negatively impact the river and reduce its recreation value for the people in the town.
- Completing the ecotourist park may provide education and recreation for many people in the local area.

2 marks

1 mark for identifying one impact of the project.
1 mark for explaining the impact on the current population.

d. *For example, any two of the following costs:*

- noise pollution during construction
- dust and dirt created by construction
- increased traffic when the ecotourist park is operating
- reduction in natural spaces for recreational use
- further degradation of the aesthetic value of the river

2 marks
1 mark for each cost identified.

For example, any two of the following benefits:

- job creation for locals
- an increase in the money available to improve infrastructure (for example, building schools or hospitals)
- increased tourism potentially leading to more jobs being created
- increased educational opportunities provided by the ecotourist park

2 marks
1 mark for each benefit identified.

e. Consultation with Traditional Owners is an important part of decision-making, especially for projects such as the one proposed, which may have a significant impact on the surrounding area. 1 mark

The long-term knowledge of the land and its significance to First Nations peoples must be represented in project decisions. 1 mark

Question 4 (11 marks)

a. carbon dioxide 1 mark

b. Farming large amounts of microalgae increases carbon sequestration 1 mark
as the microalgae absorbs carbon dioxide from the atmosphere
via photosynthesis, 1 mark
which reduces the amount of carbon dioxide in the atmosphere. 1 mark

c. The reduction of carbon dioxide in the atmosphere 1 mark
would cause a reduction in the absorption and re-emission of heat energy
from the greenhouse effect, 1 mark
thus decreasing global temperatures. 1 mark

d. *For example:*

- using effluent wastewater that has been treated and can then be pumped into microalgae ponds
- using stormwater or captured rainwater to avoid taking from local waterways

2 marks
1 mark for each appropriate method suggested.

e. *For example, any one of:*

- Long-term reduction in global temperatures could mean that future generations will be less impacted by climate change.
- The production of animal feed could mean that future generations will have greater access to land for agricultural purposes.

2 marks
1 mark for identifying an impact of large-scale microalgae farming.
1 mark for explaining the identified impact on intergenerational equity.

Question 5 (9 marks)

a. $51 - 37 = 14$

$\frac{14}{37} = 0.38$

$0.38 \times 100 = 38\%$ increase

2 marks
1 mark for providing the correct working.
1 mark for calculating the percentage increase.
Note: Accept answers within the range of 37−43%.

b. *For example, any one of:*

- If the 2030 emission targets are met, the best-case scenario will be a 1.8°C increase in global temperatures; however, global temperatures could still increase by up to 2.5°C even if these targets are met.
- If governmental policies and actions are implemented, but emission targets are not reached, then global temperatures will increase by up to 2.9°C.

2 marks
1 mark for providing a concluding statement.
1 mark for referring to data in the graph.

c. Projections are predictions that are made based on climate modelling. 1 mark

There are a range of projections to account for unknown future factors, such as a decrease in fossil fuel combustion or stabilisation of the human population. 1 mark

d. *Any one of:*

- climate scientists
- oceanographers
- arctic scientists

1 mark

e. More female hawksbill sea turtles will be be born than males, 1 mark
leading to a decline in population numbers due to gender imbalance. 1 mark

Question 6 (10 marks)

a. Marine organisms die and are buried on the ocean floor. 1 mark

Over time, the organisms are covered with layers of silt and sand. 1 mark

Over millions of years, heat and pressure causes oil and natural gas deposits to form where the organisms are buried. 1 mark

b. Natural gas contains chemical potential energy, 1 mark
which is converted to thermal energy through combustion. 1 mark

c. Extracting natural gas releases methane during the drilling process, as does extracting brown coal. 1 mark

Both resources require also require using machinery that releases carbon dioxide. 1 mark

d. Although the extraction of brown coal, which is currently used to generate electricity, releases methane and requires the use of machinery that releases carbon dioxide, 1 mark
electricity can also be generated using renewable resources such as solar, hydro and wind power. 1 mark
Therefore, phasing out gas means that renewable sources of energy can be implemented, which will reduce carbon dioxide emissions over the long term. 1 mark

Question 7 (9 marks)

a. Photovoltaic cells absorb solar energy from the Sun. 1 mark

This energy causes electrons to flow as an electrical current. 1 mark

The electrical current is then transferred via powerlines to consumers. 1 mark

b.
$$\frac{\text{annual energy output}}{\text{annual energy input}} = 0.2$$

$$\text{annual energy input} = \frac{761\,567}{0.2}$$

$$= 3\,807\,835\,\text{MWh}$$

2 marks

1 mark for providing the correct working.
1 mark for calculating the annual energy input in MWh.

c. The second law of thermodynamics states that energy is always lost during conversions. 1 mark

The annual energy input calculation shows that energy is lost during conversion, as the annual energy input is far greater than the annual energy output of the solar panels . 1 mark

d. *For example, any one of:*

- Further clearing of land for construction can impact biodiversity.
- Changes in land use may impact erosion.
- Fossil fuels used during construction emit greenhouse gases that contribute to the enhanced greenhouse effect.

2 marks
1 mark for describing one environmental cost.
1 mark for linking to the solar farm construction.

Question 8 (14 marks)

a. **i.** number of blades on the turbine 1 mark

ii. volts of electricity generated 1 mark

b. More blades may collect more wind from the fan, causing the turbine to spin faster and, thus, generate more electricity. 1 mark

c. The results do not support the students' initial hypothesis. The graph does not show a positive linear relationship between the number of volts produced and the number of blades attached to the wind turbine. 1 mark

For example, when 6 blades were used, 0.55 volts of energy were produced; whereas, when 12 blades were used, 0.4 volts of energy were produced. 1 mark

d. Repeatability refers to an experiment's ability to produce the same or similar results when carried out under the same conditions by the same experimenter(s). 1 mark

The students conducted multiple trials for each of the five experimental groups, which ensured that the same experiment could be carried out under the same conditions to achieve similar results. 1 mark
1 mark

e. **i.** random error 1 mark

ii. Sarah is correct. Random errors are unpredictable errors that are different each time, resulting in a wide spread of data. 1 mark

Precision refers to the closeness of data across multiple trials using the same independent variable. Thus, the wide spread of data caused by random errors would impact the precision of the experiment. 1 mark

Accuracy refers to how close the data is to the true value of the measurement. 1 mark

f. *For example, any one of:*

- The wind turbine used in this experiment is a model, which may not necessarily be able to mimic the conditions of a real wind turbine, which works on a much larger scale.
- Random errors occurred during the experiment, meaning that the data cannot be generalised.

2 marks
1 mark for identifying one limitation.
1 mark for describing the identified limitation.