

VCE Environmental Science Units 3&4

Written Examination

Suggested Solutions

SECTION A – MULTIPLE-CHOICE QUESTIONS

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

Question 1 B

B is correct. A provisioning service provides resources for human use or consumption. In this case, the Glyde River provided fish that humans could consume as food.

A is incorrect. The Glyde River's contribution to the global water cycle is a supporting service.

C is incorrect. Seed dispersal is a regulating service.

D is incorrect. Sense of place is a cultural service.

Question 2 A

A is correct. Ecosystem diversity refers to the number of different habitats and ecosystems on Earth. In this case, the tropical grasslands, coastal mangroves, floodplains and open woodlands are representative of the ecosystem diversity of Arnhem Land.

B is incorrect. This option refers to species diversity.

C is incorrect. This option refers to genetic diversity.

D is incorrect. This option refers to endemic species, which does not directly relate to the definitions of biodiversity.

Question 3 A

A is correct. A species is endemic to an area where they are exclusively found. As the hooded parrot is found only in the Northern Territory, it is endemic to that region.

B is incorrect. The term endemic is not linked to susceptibility to inbreeding.

C is incorrect. Although endemism may impact population size, endemic species do not necessarily need protection from the IUCN because they are endemic.

D is incorrect. The term endemic is not linked to cultural burning.

Question 4 C

C is correct. The El Niño–Southern Oscillation is a medium-term environmental change as it cycles approximately every eight years. It is caused by above-average sea surface temperatures in the tropical Pacific Ocean.

A and **B** are incorrect. The El Niño–Southern Oscillation is not a long-term change and these options do not describe the cause of this phenomenon.

D is incorrect. The El Niño–Southern Oscillation is not a short-term change and it is not caused by volcanic activity.

Question 5 D

D is correct. A population with high genetic diversity has a variety of alleles, allowing it to adapt and become resistant to environmental changes.

A is incorrect. Populations with low genetic diversity are susceptible to inbreeding.

B is incorrect. Reintroduced populations may experience genetic swamping, but there is no link between genetic swamping and high genetic diversity.

C is incorrect. Populations with high genetic diversity have a variety of alleles, meaning that they will be more resistant to rapid changes such as bushfires.

Question 6 C

C is correct. Fossil evidence of an organism in a region can provide evidence of the diversity of species that have lived in that region over time. In this case, fossil evidence of the Tasmanian tiger in the Wellington Caves shows that the organism likely lived in the region of the Wellington Caves at some point in history.

A is incorrect. There is no historical evidence to suggest that Tasmanian tigers were domesticated prior to extinction.

B is incorrect. Fossil evidence of the Tasmanian tiger in the Wellington Caves does not provide evidence of when the Tasmanian tiger became extinct.

D is incorrect. Though the last remaining Tasmanian tiger may have been held in captivity in Sydney, this would not lead to fossil remains in the Wellington Cave.

Question 7 A

A is correct. Bones and other hard tissues are the most easily preserved material in animals.

B is incorrect. Fur is rarely fossilised as it generally decomposes before fossilisation can occur.

C is incorrect. Although DNA can be isolated from fossilised bones, the bones are the actual remains that would be found in the Wellington Caves.

D is incorrect. Footprints are an example of trace fossils and are less likely to be discovered in a cave than bones.

Question 8 C

C is correct. Intergenerational equity considers the impacts and benefits of a project on both current and future generations. Lower-cost water bills benefit the current generation, and reduced landfill benefits both current and future generations.

A is incorrect. This option does not consider future generations.

B is incorrect. This option outlines a negative impact on the current generation.

D is incorrect. This option does not consider the impacts on the current generation.

Question 9 D

D is correct. Circular economy thinking involves planning for the reduction of waste and pollutants. In the scenario, the waste methane produced by biomass carbonisation is used to power a water recycling plant, thus reducing the amount of waste.

A is incorrect. A regulatory framework is a legal mechanism that outlines processes and procedures.

B is incorrect. The lithosphere is the hard outer layer of Earth; this project focuses on other spheres of Earth.

C is incorrect. There is no evidence of the recycling project or any of its stakeholders ignoring the precautionary principle.

Question 10 B

B is correct. Technocentrism is a value system that focuses on using technology to protect the environment. This project uses biomass carbonisation, a new technology, to create soil enhancer. The capture and reuse of methane can also be viewed as technocentric.

A is incorrect. Anthropocentrism is a value system that focuses on benefiting humans. This project also considers protecting and improving the environment.

C and **D** are incorrect. Both biocentrism and ecocentrism place the natural environment at the centre of all decisions. In this project, increasing revenue is also considered, meaning that protection of the natural environment is not the only driving factor of the project.

Question 11 A

A is correct. Using methane to run the water recycling facility means that the facility will not have to purchase power from the electrical grid. In Australia, the electrical grid is still powered mostly by coal and fossil fuels, so using methane will reduce the amount of fossil fuels being consumed.

B is incorrect. Regulatory frameworks being imposed by the local council would not necessarily lead to environmentally responsible projects.

C is incorrect. It is unlikely that there is a link between using methane to power the water recycling facility and health issues in local residents.

D is incorrect. Methane has a higher global warming potential than coal.

Question 12 A

A is correct. A risk analysis is one part of an environmental management plan when undertaking a project such as the upgrade of hiking trails.

B is incorrect. Local residents would not have input on risk management in this project.

C is incorrect. The risk analysis is mostly qualitative.

D is incorrect. The risk analysis does not outline the benefits of each risk.

Question 13 D

D is correct. The disruption of habitats along the hiking trails would disrupt the species living in those habitats and would therefore impact Earth's biosphere.

A is incorrect. Carbon monoxide and particulate matter emitted from the earth-moving machinery would impact Earth's atmosphere, not Earth's lithosphere.

B is incorrect. The loss of small ground-dwelling orchids would impact Earth's biosphere, not Earth's hydrosphere.

C is incorrect. The runoff from the work site entering waterways would impact Earth's hydrosphere, not Earth's biosphere.

Question 14 C

C is correct. In the natural greenhouse effect, greenhouse gases in the troposphere absorb infrared radiation.

A is incorrect. Ultraviolet radiation is absorbed in the stratosphere, not the troposphere.

B is incorrect. Visible light always reaches Earth.

D is incorrect. The albedo effect is relevant in the troposphere, not the stratosphere.

Question 15 A

A is correct. Natural levels of carbon dioxide in the atmosphere remain relatively stable due to photosynthesis and cellular respiration in the carbon cycle.

B is incorrect. A volcanic eruption would show a spike in carbon dioxide levels.

C and **D** are incorrect. The albedo effect and ocean currents do not directly impact natural carbon dioxide levels.

Question 16 C

Subtracting the initial value (1960) from the final value (2020) to find the difference in emissions gives:

$$36 - 8 = 28$$

Dividing the difference by the initial value gives:

$$\frac{28}{8} = 3.5$$

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

$$3.5 \times 100 = 350\%$$

Question 17 A

A is correct. Clearing forests for industrial agriculture involves the removal of carbon sinks, the release of stored carbon dioxide and emission of carbon dioxide from machinery; therefore, it is the greatest contributor to greenhouse gas emissions.

B is incorrect. Livestock do emit methane, but they are not the greatest contributors to greenhouse gas emissions.

C is incorrect. Although water vapour is a greenhouse gas, water vapour results from the process of photosynthesis, not irrigation.

D is incorrect. Both greenhouse gas emissions and animal welfare are issues that must be considered in industrial agriculture.

Question 18 B

B is correct. Warmer springs will cause the orchid to flower earlier; however, if the activity of the sugarbag bee remains the same, pollination will not occur and seed fertilisation will be reduced.

A is incorrect. The orchid will not flower later to avoid a warm spring, as a warmer spring is more likely to cause earlier flowering.

C is incorrect. As rainforests in Australia are already found at low altitudes, the orchid and sugarbag bee are unlikely to migrate to a lower altitude.

D is incorrect. Climate change is likely to reduce rain and cause longer droughts.

Question 19 C

C is correct. Reducing the cost of electric vehicles will reduce the number of fuel-combusting engines on the road. In turn, this will reduce greenhouse gas emissions and lead to less absorption of heat by greenhouse gases in the atmosphere.

A and **B** are incorrect. This program is an example of a mitigation strategy, not an adaptation strategy.

D is incorrect. Although the program is only available to residents in a particular state, the mitigation strategy is relevant to all Australians.

Question 20 A

A is correct. Solar activity changes with the seasons as Earth's tilt is altered. This impacts sea surface temperature due to variations in the amount of solar energy reaching Earth.

B is incorrect. A decrease in the albedo effect can increase global temperatures in a positive feedback cycle, which may increase sea surface temperatures.

C is incorrect. Sea surface temperatures can be collected from all oceans.

D is incorrect. Sea surface temperatures and air temperatures are measured using the same standard scales of temperature measurement, which is degrees Celsius.

Question 21 D

D is correct. Fracking is used to extract coal seam gas by applying high-pressure water or sand to fracture rock, which releases the coal seam gas contained within.

A, B and C are incorrect. These energy sources are not extracted through fracking.

Question 22 C

C is correct. Mechanical rehabilitation strategies involve physically moving or removing components of a mine site. Therefore, only dredging mud and sludge is a mechanical rehabilitation strategy.

A and B are incorrect. These options are biological rehabilitation strategies.

D is incorrect. This option is a chemical rehabilitation strategy.

Question 23 D

D is correct. Uranium is non-renewable, as it is a finite resource, and a non-fossil fuel, as it was not formed when prehistoric plants and animals died.

A, B and C are incorrect. These options do not describe the energy source provided by uranium.

Question 24 B

B is correct. The first type of energy in the conversion, the movement of the wind, is kinetic energy; the second type of energy in the conversion, the movement of the turbine, is mechanical energy; and the third type of energy in the conversion, the electrical generator, is electrical energy.

A and C are incorrect. Potential energy refers to energy that is stored in an object; it is not involved in the energy conversion shown.

D is incorrect. Thermal energy refers to energy that contributes to temperature; the movement of the wind is not a form of thermal energy.

Question 25 A

Converting the percentage efficiency of both steps in the energy conversion gives:

$$80\% = 0.8 \text{ and } 90\% = 0.9$$

Multiplying the decimals together gives:

$$0.8 \times 0.9 = 0.72$$

Multiplying the result by 100 to find the approximate overall energy efficiency of the wind turbine gives:

$$0.72 \times 100 = 72\%$$

Question 26 C

C is correct. Reducing the use of coal as an energy source will reduce the emission of carbon dioxide, which will reduce the town's contribution to the enhanced greenhouse effect.

A is incorrect. An increase in construction jobs is a sociocultural reason for using wind energy instead of coal energy, not an environmental reason.

B is incorrect. Loss of habitat may not necessarily reduce pest species.

D is incorrect. It is not likely that the town's contribution to the natural greenhouse gas effect will be reduced.

Question 27 C

C is correct. One of the main disadvantages of wind power is its intermittent nature; the presence of the Sun is more consistent than the presence of wind.

A is incorrect. Wind power being more energy efficient than solar energy is an advantage, not a disadvantage.

B is incorrect. Wind power does not disrupt more water flow than hydroelectric power.

D is incorrect. Wind power being more readily available than geothermal power is an advantage, not a disadvantage.

Question 28 A

A is correct. Random error refers to variations in measurements that occur unexpectedly; they are reduced by conducting multiple trials and taking multiple measurements. Thus, increasing the number of trials will reduce the chance of random errors.

B is incorrect. Systematic errors result from the use of inaccurate measuring equipment and will be consistent even if multiple trials are conducted.

C is incorrect. Personal errors result from mistakes or miscalculations, which may not be reduced by increasing the number of trials.

D is incorrect. Increasing the number of trials will not impact the occurrence of outliers.

Question 29 B

B is correct. The dependent variable is the variable that is being measured. In this experiment, the mass of the balloons is being measured.

A is incorrect. The type of organic matter is the independent variable.

C is incorrect. The mass of organic matter is a controlled variable.

D is incorrect. The species of kangaroo is not necessarily a consideration in this experiment.

Question 30 A

A is correct. This experiment is measuring the amount of biogas produced from different types of organic waste. Both carbon dioxide and methane are released when organic matter breaks down.

B, C and D are all incorrect. These options do not identify the gases produced in this experiment.

SECTION B**Question 1** (11 marks)

- a. The species richness in the Amazon Rainforest is greater than the Cerrado savanna for all organisms listed in the table.

For example, there are 1700 more species of trees in the Amazon rainforest than in the Cerrado savanna.

2 marks

1 mark for providing a comparative statement about the species richness.

1 mark for using data in the table to compare the species richness.

- b. For example, any two of:

- climate
- rainfall
- habitat structure
- elevation variation

2 marks

1 mark for each factor provided.

- c. To calculate the Simpson's Index of Diversity (SID), the student needs to know the number of different species
and the abundance of each species.

1 mark

1 mark

- d. For example, any one of:

- Mark-recapture is a sampling method that involves capturing individual organisms, then tagging and releasing them. Later, more individuals are recaptured and the number of tagged individuals in that sample is used to estimate the population.
- Camera traps are a sampling method that involves setting up remote sensor cameras and recording footage over a period of time. The footage can be used to count the number of different mammal species that passed by the camera, thus estimating the number of species in the area.

3 marks

1 mark for naming a relevant sampling method.

1 mark for outlining the sampling method.

1 mark for outlining how the method is used to estimate numbers.

e. *For example, any two of:*

- loss of biodiversity due to animals and plants being killed by machinery or falling trees
- loss of biodiversity due to loss of habitat when trees were removed and smaller understorey plants were killed
- increased global warming due to the loss of carbon sinks that remove carbon dioxide from the atmosphere
- increased erosion due to the loss of topsoil that was held together by trees
- increased numbers of wildfires as the many tons of water vapour released by the trees through transpiration is lost

2 marks

1 mark for each environmental impact described.

Question 2 (12 marks)

- a. The deer move through the densely packed foliage, which interrupts the interlocked branches and destroys the nests and nesting spots of the helmeted honeyeater. 1 mark
1 mark
- b. Increasing global temperatures 1 mark
lead to drier conditions in the eucalypt forest, 1 mark
which could increase the frequency of fires that can destroy the helmeted honeyeater's habitat and/or helmeted honeyeaters directly. 1 mark
- Note: Other relevant impacts include increased drought impacting the eucalypt species; less water being available for the helmeted honeyeater to consume; and loss of eucalypt species leading to loss of food sources for the helmeted honeyeater.*
- c. i. *Flora and Fauna Guarantee Act (Vic)* 1 mark
- ii. This framework legally requires conservation strategies to be implemented. 1 mark
- d. Creating a wildlife corridor by connecting the fragmented woodlands 1 mark
provides the helmeted honeyeater a larger habitat for nesting and protection from predators. 1 mark
- e. Captive helmeted honeyeaters can be selectively mated. 1 mark
This can increase the total number of helmeted honeyeaters that can be reintroduced into the wild population. 1 mark
- f. The helmeted honeyeater faces an extremely high risk of extinction in the near future. 1 mark

Question 3 (12 marks)**a.** *For example:*

Monica should choose option B.

In terms of environmental benefits, option B clearly outweighs option A. In option B, Monica can keep most of the current woodland on the property, therefore maintaining the habitat for the species living there. The woodland currently acts as a small carbon sink, contributing to the absorption of carbon dioxide and helping to mitigate climate change. If Monica chose option A, the woodland would need to be cleared, which would add carbon to the carbon cycle. Additionally, no unethical practices against livestock would occur in option B, meaning that there would be no harm to animals.

Although the potential annual profit is not as high in option B, it is still possible for Monica to make a living from the produce on the farm. \$90 000 is a livable income and there is always the possibility of expansion if required. In option B, Monica only needs to employ one worker to assist with running the farm. Therefore, if the minimum wage increases, there is less pressure on Monica if she has one employee than if she had three employees. The set-up cost of option B is also cheaper, as most of the infrastructure for the chicken coop and vegetable gardens is already present.

From a sociocultural viewpoint, moving away from unethical farming practices by choosing option B would ensure Monica is more favourably viewed by her community. Monica's brother would not be disappointed, as the welfare of the animals would not be an issue. Monica would be supporting the local farmers' market by regularly attending to sell produce.

6 marks

1 mark for describing the environmental benefits of the option chosen.

1 mark for describing the social benefits of the option chosen.

1 mark for describing the economic benefits of the option chosen.

1 mark for describing the environmental costs of the alternative option.

1 mark for describing the social costs of the alternative option.

1 mark for describing the economic costs of the alternative option.

Note: Students are required to discuss the positive factors of the chosen option as well as the negative factors of the alternative option. Students should present these factors as an argument for their chosen option.

b. The principle of efficiency of resource use states that projects should use the resources available to them and minimise waste.

1 mark

Monica could consider the resources already available on the property, such as the existing vegetable gardens, the infrastructure for the chicken coop and the mature trees. Monica should make use of these resources rather than buying new products or materials when setting up her business.

1 mark

c. *For example, any one of:*

- the local council
They may approve or deny a permit for the business that Monica will choose to run.
- conservation groups
Their values regarding the conservation of local native species and their work to protect these species may influence Monica's decision.

2 marks

1 mark for naming a relevant stakeholder.

1 mark for describing how the stakeholder may influence Monica's decision.

d. *For example, any one of:*

- Effluent produced by livestock may run into the stream on the property and cause eutrophication.
- Clearing the woodland may disrupt the water table and increase salinity on the property.
- The livestock's high need for water may cause water scarcity on the property.

2 marks

1 mark for identifying a negative impact of option A.

1 mark for describing the impact on the hydrosphere.

Question 4 (11 marks)

- a. Extraction of groundwater (from the on-site aquifer) for splitting hydrogen and oxygen to create the liquid hydrogen is an environmental concern. 1 mark

This may disrupt the water cycle, leading to scarcity or onflow of environmental issues in local waterways. 1 mark

- b. This project is working to minimise consumption and promote the use of renewable resources. 1 mark

The whole plant is to be powered by solar and wind power, therefore eliminating the consumption of fossil fuels. 1 mark

The road trains transporting the liquid hydrogen will be powered by the liquid hydrogen; therefore, the resource will be reused and the road trains will not need to rely on petroleum. 1 mark

c. *Any one of:*

- A community may choose to produce electricity using hydrogen fuel cells to reduce greenhouse gas emissions, as the combustion of coal is a much larger contributor to global warming and the enhanced greenhouse effect than hydrogen fuel cells.
- A community may choose to produce electricity using hydrogen fuel cells for efficiency of resource use, as hydrogen power is more efficient in energy conversions than coal.
- A community may choose to produce electricity using hydrogen fuel cells because hydrogen is a renewable resource as opposed to coal, which is a non-renewable source.

2 marks

1 mark for identifying a valid reason.

1 mark for providing an appropriate explanation.

- d.
1. Identify the regulatory frameworks governing the environmental aspects of the project. 1 mark
 2. Complete an environmental impact assessment by describing the likelihood of impacts on the environment and safeguards to minimise the impacts. 1 mark
 3. Survey stakeholders to gather views and expert data. 1 mark
 4. Develop environmental management procedures for the ongoing monitoring of the environment to manage and minimise risk. 1 mark

Question 5 (12 marks)

- a.** There is an increasing trend in sea height variation between 1993 and 2020 that fluctuates seasonally. 1 mark

Reading from the graph, the sea height variation was 0 mm in 1993 and increased to approximately 90 mm by 2020. 1 mark

One reason for this trend is thermal expansion caused by global warming. 1 mark

- b.** *For example, any one of the following anthropocentric impacts:*

- damage to homes and infrastructure located close to the shoreline
- total loss of homes and infrastructure close to the shoreline
- loss of income from businesses close to the shoreline
- loss of agricultural land that leads to food insecurity

1 mark

For example, any one of the following environmental impacts:

- loss of habitat for shore- and dune-nesting birds
- loss of coral reef species
- loss of shore and dune plant species
- disruption of habitat for shore- and dune-dwelling species

1 mark

- c.** *For example, any one of:*

- The government of Kiribati could build sea walls to protect buildings and infrastructure close to the shoreline.
- The government of Kiribati could upgrade existing buildings so that they can withstand potential water damage or erosion of the lithosphere.

2 marks

1 mark for stating the adaptation strategy.

1 mark for describing how the strategy helps local communities build resilience against rising sea levels.

- d.** Intragenerational equity refers to providing access to resources for all people in the current generation. 1 mark

This project will ensure that rising sea levels will not lead to further water scarcity for the population in Kiribati. 1 mark

- e.** The use of solar energy to power the desalination plant means that fossil fuel energy will not be needed. 1 mark

This will reduce the carbon dioxide being released and in turn 1 mark

reduce the absorption of heat in the atmosphere **OR** reduce the contribution to the enhanced greenhouse effect. 1 mark

Question 6 (5 marks)

- a. The IPCC confidence levels consider the quality of climate evidence as well as scientific agreement with this evidence to predict changes in the environment due to climate change. 1 mark
The level of confidence is expressed using a scale of very low, low, medium, high and very high. 1 mark
- b. A climate that is increasing in temperature will cause ice to melt. 1 mark
When glaciers melt, the meltwater flows into the ocean and the remaining glacier has less mass; thus, reducing glacial mass indicates a heating environment. 1 mark
- c. the albedo effect 1 mark

Question 7 (12 marks)

- a. *For example:*
The combustion of natural gas releases carbon dioxide, 1 mark
which absorbs infrared radiation that has been re-emitted from Earth's surface. 1 mark
This heats up the carbon dioxide and the re-radiated heat contributes to the enhanced greenhouse effect. 1 mark
Note: Responses may also refer to methane released during the extraction of natural gas.
- b. Ocean animals such as whales, dolphins and fish will experience disruptions to their feeding and breeding cycles, 1 mark
which will disrupt the food webs of the ecosystem and lead to a loss of biodiversity. 1 mark
- c. A solar farm requires an open area without trees or buildings blocking sunlight access, 1 mark
and open ground or building surfaces to fix the solar panels to. 1 mark

- d. i. Peak demand refers to the times during the day when energy demand is at its highest. 1 mark
- ii. *For example, any one of:*
- I do agree with the stakeholders. Peak demand is usually between 4 and 8 pm, when the sun is less powerful. As sunlight is not shining all the time, electricity will be intermittent and will only reliably occur during times when the solar panels can absorb sunlight.
 - I do not agree with the stakeholders. Although sunlight is intermittent, battery technology has significantly improved and the city can install large lithium batteries, which will allow them to store energy for when the sun has set.

2 marks

1 mark for providing a valid reason for agreeing OR disagreeing with the stakeholders' concerns.

1 mark for linking the reason to peak demand.

- e. *For example, any one of:*
- The use of solar panels will reduce greenhouse gas emissions, thus reducing contributions to global warming and the enhanced greenhouse effect.
 - Solar panels are a renewable resource, which negates the need to use finite sources.
 - The use of solar panels will reduce land degradation from coal mining, thus maintaining ecological integrity.

2 marks

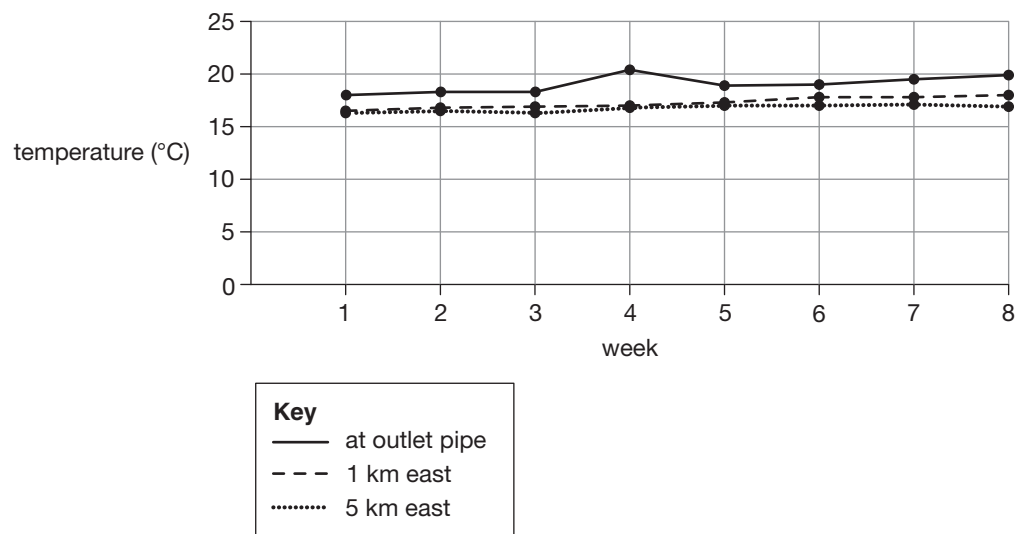
1 mark for identifying a valid environmental reason.

1 mark for describing the environmental reason.

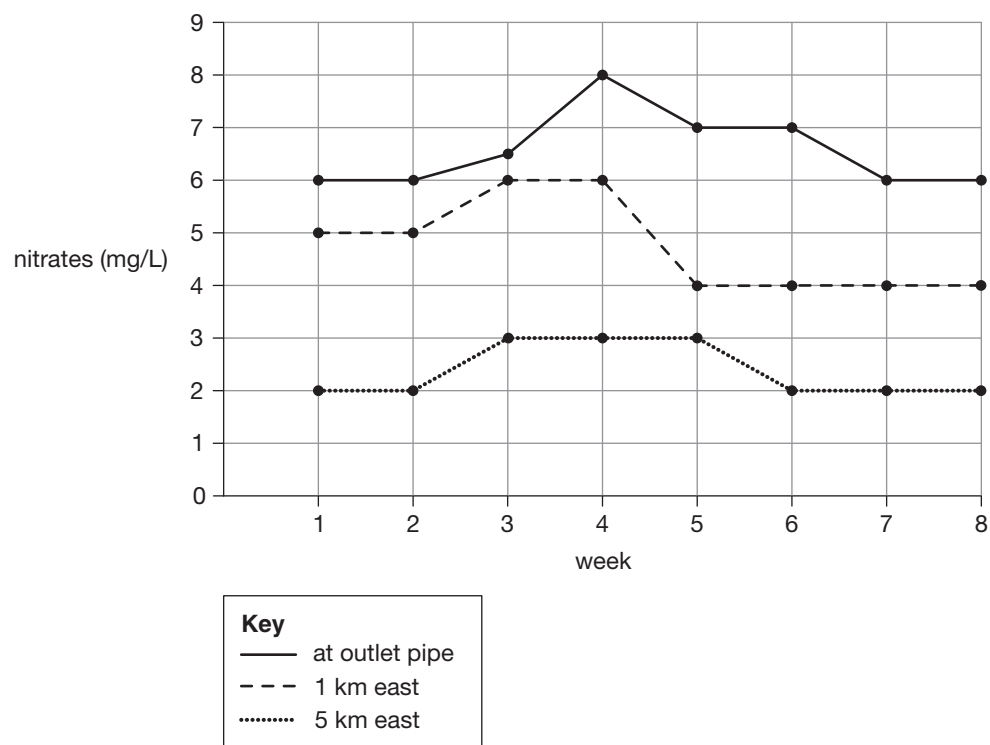
Question 8 (15 marks)

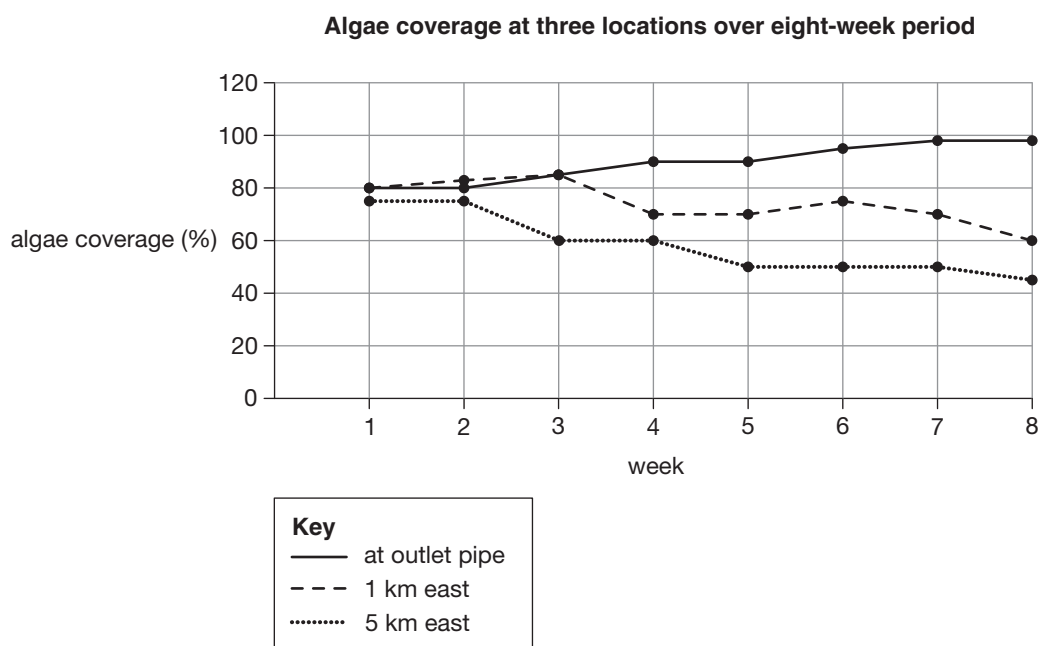
a. For example, any one of the following graphs:

Temperature at three locations over eight-week period



Nitrates at three locations over eight-week period





5 marks

1 mark for providing a title that includes the independent and dependent variables.

1 mark for using an appropriate label and scale on the x-axis.

1 mark for using an appropriate label and scale on the y-axis.

1 mark for plotting the data points.

1 mark for drawing a line of best fit for each location and providing a key.

- b. The data in table 1 shows that the outlet pipe is having an impact on the reef. All three indicators have higher values at the outlet pipe; these values decrease as the distance from the outlet pipe increases.

For example, any two of the following pieces of evidence:

- Although there were slight fluctuations in temperature over the eight-week period, the temperature at the outlet pipe ranged from 18–20°C, while the temperature only reached a maximum of 17°C 5 km east of the pipe.
- There is a difference of approximately 4 mg/L between the nitrate levels measured at the outlet pipe and those measured 5 km east of the outlet pipe.
- Algae growth, which can indicate high levels of nutrients, is similar in all three locations in week 1 (75–80% coverage), but the difference increases to 52% by week 8.

3 marks

1 mark for identifying the general trend in the data.

1 mark for each piece of evidence provided.

Note: Responses must include data to receive full marks. One piece of evidence must refer to the graph drawn in **Question 8a**.

- c. All three indicators are different types (physical, chemical and biological), which ensures the students can examine a broad range of information about the health of the ecosystem.

1 mark

1 mark

d. *For example, any one of the following safety considerations:*

- Use sun protection when working outdoors.
- Be cautious working around water.
- Carefully follow the instructions when using electronic data probes.
- Carry a first aid kit in case of bites or stings from marine creatures.
- Wear personal protective equipment (PPE) when working with or near polluted water.

1 mark

For example, any one of the following ethical considerations:

- Take care not to disrupt the habitat of species in the area.
- Do not remove any shells or other organisms from their habitat.
- Be cautious not to disturb organisms when laying down the quadrat.

1 mark

Note: Accept any other relevant safety precautions and ethical considerations.

e. *For example, any one of:*

- using uncalibrated digital probes, which is a systematic error
- misusing digital probes, which is a random error
- inconsistent counting when estimating the percentage of algae coverage in the quadrat, which is a personal error

2 marks

1 mark for identifying an appropriate source of error.

1 mark for stating the type of error

f. *For example, any one of:*

- ensuring that the digital probes are calibrated correctly after each week's measurements
- reading the instructions carefully when using new equipment
- increasing the number of trials for each week's measurements
- ensuring that all group members agree on the percentage of algae coverage for each week's measurement

1 mark

*Note: Accept any appropriate method for reducing error, as long as it corresponds with the error identified in **Question 8e**.*