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Write your **student number** in the boxes above. **Letter**

Environmental Science

Question and Answer Book

VCE Examination – Friday 14 November 2025

- Reading time is **15 minutes**: 11.45 am to 12 noon
- Writing time is **2 hours**: 12 noon to 2.00 pm

Approved materials

- One scientific calculator

Materials supplied

- Question and Answer Book of 36 pages
- Multiple-Choice Answer Sheet

Instructions

- Follow the instructions on your Multiple-Choice Answer Sheet.
- At the end of the examination, place your Multiple-Choice Answer Sheet inside the front cover of this book.

Students are **not** permitted to bring mobile phones and/or any unauthorised electronic devices into the examination room.

Contents

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

VICTORIA State Government

Section A – Multiple-choice questions

Instructions

- Answer **all** questions in pencil on your Multiple-Choice Answer Sheet.
- 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

Many historical mass extinctions were caused by

A. climate change.

B. flash flooding in rivers.

C. loss of endemic species.

D. direct impacts from meteors.

Question 2

Why does rapid species diversification often follow a period of mass extinction?

A. A large percentage of species survive a mass extinction.

B. More ecological niches are available following mass extinction events.

C. One dominant species survives the period of mass extinction and may reproduce to form many genetically similar offspring.

D. Many species die out in a mass extinction, resulting in little reproduction.

Question 3

When dating fossils, a scientist will test several samples from the same specimen under the same conditions.

Comparing the results from these samples will provide a measure of

A. validity.

B. accuracy.

C. repeatability.

D. reproducibility.

Question 4

The difference between pollination and seed dispersal is that

A. pollination is conducted only by insects and seed dispersal is conducted by most birds.

B. flowers can be pollinated, whereas only grasses disperse seeds.

C. pollen cannot be found in gene banks, whereas seeds make up gene banks.

D. pollination can lead to the formation of seeds, while dispersal is the spreading of seeds.

Question 5

The overall rate of species extinction from non-anthropogenic causes compared to anthropogenic causes

A. is slower.

B. is faster.

C. is equal.

D. cannot be determined.

Question 6

A key factor that influences ecosystem diversity is

A. disease.

B. tectonic plate movements.

C. consideration of edge effects in sampling.

D. captive breeding programs that increase the population size.

Use the following information to answer Questions 7 and 8.

Victoria's Container Deposit Scheme was introduced to increase the recycling of bottles, drink cartons and aluminium cans. It aims to reduce Victoria's litter by up to half by offering a financial reward for returning drink containers for recycling. By charging manufacturers an extra 10 cents per container, the scheme also puts the costs of preventing pollution and managing waste back on those responsible for generating the waste material.

Question 7

The purpose of the scheme is focused on

A. stakeholder values.

B. cost-benefit analysis.

C. circular economy thinking.

D. the precautionary principle.

Question 8

The concept of passing on the costs of managing waste demonstrates

A. a regulatory framework.

B. the user pays principle.

C. intragenerational equity.

D. integrated sustainability assessment.

Question 9

In 2023, the Australian Pesticides and Veterinary Medicines Authority (APVMA), a federal government organisation, reviewed scientific information on the harmful effects of using the insecticide chlorpyrifos, which had been in use since the 1960s. The APVMA decided to ban the use of chlorpyrifos.

The review and banning of this chemical was the result of

A. an understanding of the efficiency of resource use.

B. the correct application of the precautionary principle.

C. the application of new technologies to solve the risk.

D. the regulatory framework that informs environmental management strategies.

Question 10

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

A. protecting endangered organisms and the ecosystems in which they exist

B. saving species, their habitats and ecosystems from excessive rates of extinction and the disruption of biotic interactions

C. providing programs that restore ecosystem health to address anthropogenic harms

D. actions that maintain the diversity and quality of ecosystems and enhance their capacity to adapt to change and provide for the needs of future generations

Use the following information to answer Questions 11 and 12.

In 2024, Antarctica recorded its second lowest sea ice extent on record at 17.16 million km^2 of sea ice. This is 1.55 million km^2 less than the 1981–2010 average. Antarctica is estimated to hold 6–21 trillion tonnes of carbon in sediment stores below its ice sheet.

Question 11

As the extent of Antarctica's sea ice decreases, the region is likely to have a

A. higher albedo, due to less light-coloured surface area.

B. higher albedo, increasing the reflectivity of Antarctica.

C. lower albedo, increasing the amount of light absorbed.

D. lower albedo, resulting in less heat being re-radiated.

Question 12

Identifying the impact of melting sea ice on the carbon cycle is challenging and requires detailed modelling because

A. melting at both poles needs to be compared.

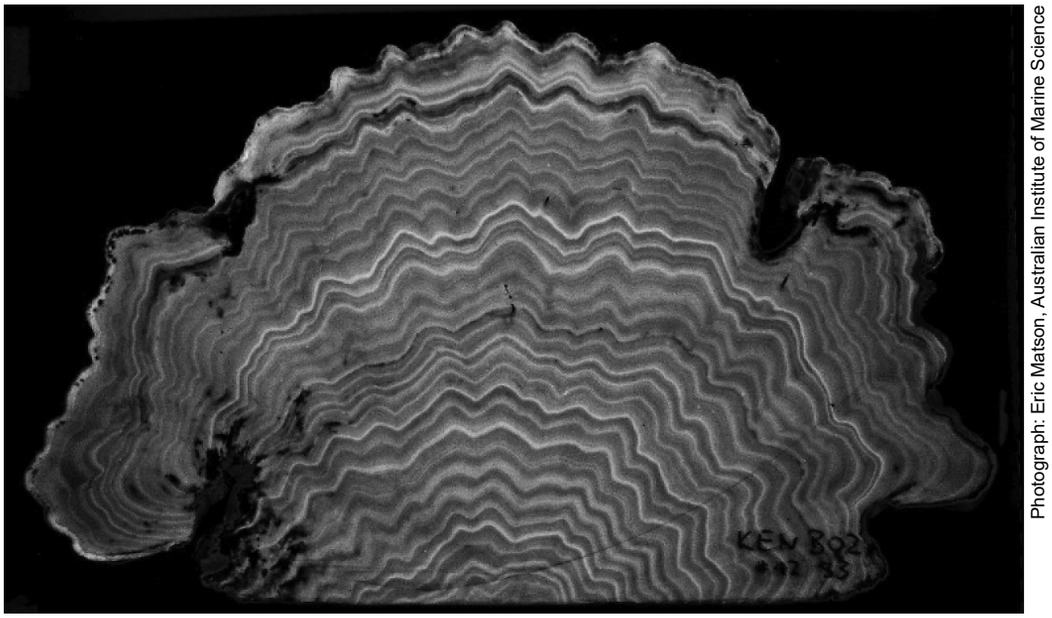
B. the carbon cycle has only been studied in land environments.

C. Earth's systems are interrelated and impact one another on a global scale.

D. scientific agreement is required for projections to have a high confidence rating.

Question 13

Fossilised coral can be used to infer past climate, including rainfall and sea surface temperature. Dark rings reflect periods of slower growth and lighter rings signify periods of faster growth.



Photograph: Eric Matson, Australian Institute of Marine Science

Source: Climate History Australia, 'Coral', <https://climatehistory.com.au/>

The use of fossilised coral is an example of

A. direct measurement of past climate.

B. a palaeoclimatic record of climate variables.

C. modelling of coral growth rates.

D. natural climate variability.

Use the following information to answer Questions 14 and 15.

The regent honeyeater is a critically endangered bird endemic to the eastern coast of Australia. The honeyeater's major food source is nectar from native flowering plants found in eucalypt forests and the bird acts as a pollinator to these plants. The honeyeater's breeding cycles are closely linked to the availability of nectar.

Question 14

Climate change may alter the flowering times of native plants.

Which one of the following would most likely be an impact of climate change on the regent honeyeater?

A. an increase in the variety of flowers available as food sources

B. an increase in reproductive rates due to increased nectar availability

C. a decrease in competition for food sources due to different flowering times

D. a decrease in reproductive rates due to flowering times not aligning with breeding cycles

Question 15

The Regent Honeyeater Project is a community group that grows and transplants native flowering plants to restore habitats for the regent honeyeater.

These actions are an example of an adaptation option because

A. they increase the available food sources.

B. the plants take carbon dioxide out of the atmosphere.

C. they aim to address the effects of climate change locally.

D. the restoration effort prevents climate change.

Use the following information to answer Questions 16 and 17.

The Victorian Government recently announced the North West Victoria Vertebrate Pest Management Project. The project will invest $550 000 to identify strategies for managing exotic pest populations such as feral pigs, rabbits and foxes. The project also aims to help farmers protect their livestock from native dingo attacks, while minimising harm to these dingoes.

Question 16

This project is an example of

A. anthropocentrism, as the government is only interested in supporting farmers.

B. ecocentrism, as the human introduction of pest species is being addressed.

C. biocentrism, as all living things, including livestock, are protected.

D. technocentrism, as farming is prioritised, without concern for the environment.

Question 17

In 2024, the dingo was listed as protected in north-west Victoria due to new scientific evidence suggesting the local dingo population was at imminent risk of extinction.

Which one of the following sustainability principles best describes this measure?

A. the precautionary principle

B. conservation of biodiversity and ecological integrity

C. intergenerational equity

D. intragenerational equity

Question 18

Which one of the following lists contains only renewable sources of energy?

A. oil, coal, nuclear, natural gas

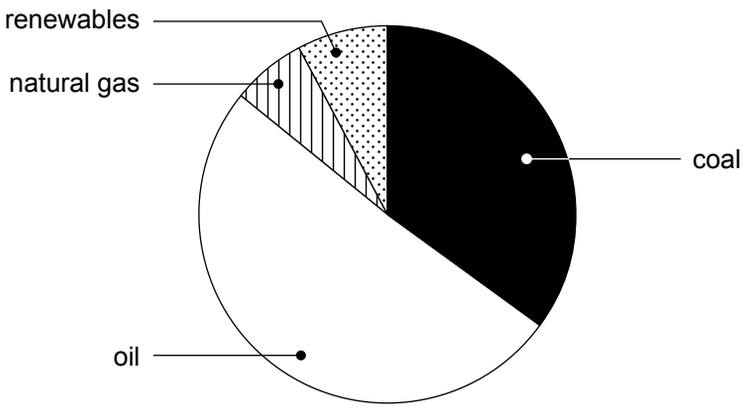
B. biomass, nuclear, solar, tidal

C. solar, wind, coal seam gas, biomass

D. geothermal, wind, hydro-electric, biofuel

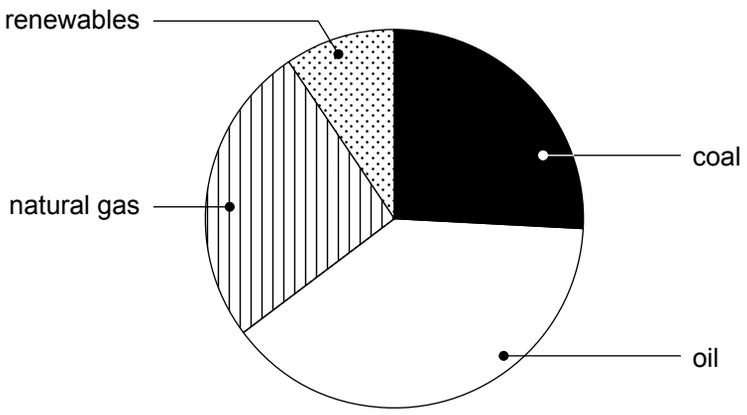
Use the following information to answer Questions 19 and 20.

Australia's energy consumption by source (1973–1974)



Data: Australian Energy Update 2021, <www.energy.gov.au/publications/australian-energy-update-2021>

Australia's energy consumption by source (2022–2023)



Data: Australian Energy Update 2024, <www.energy.gov.au/publications/australian-energy-update-2024>

In 1973, Australia's population was around 10.4 million people and used a total of approximately 2615 petajoules of energy. By 2022, Australia's population had grown to 26.1 million people and used a total of approximately 5882 petajoules of energy.

Question 19

Based on the data from 1973 to 2022

A. the percentage of oil used has not changed.

B. the amount of natural gas used has increased.

C. Australians use a lower percentage of renewable energy sources.

D. all the amounts used are similar.

Question 20

Based on the total petajoules of energy used and Australia's population, Australians used

A. the same amount of energy per person in 1973–1974 and 2022–2023.

B. less energy per person in 1973–1974 compared to 2022–2023.

C. more energy per person in 1973–1974 compared to 2022–2023.

D. just over twice the amount of energy per person in 2022–2023 compared to 1973–1974.

Use the following information to answer Questions 21 and 22.

A new prototype of wind turbine was tested to determine the efficiency of its electrical production. The data collected is shown in the table below.

Source of energy	Energy transferred to	Efficiency (%)
wind	blades	62
blades	turbine	94
turbine	generator	76
generator	electricity grid	95

Question 21

One reason the turbine does not transfer all of the wind energy to the electricity grid is that

A. some energy is converted to heat due to friction in the turbine and generator.

B. the turbine stores excess energy to send to the electricity grid when there is no wind.

C. the generator sends some energy back to spin the turbine.

D. some energy is destroyed in each transformation.

Question 22

Wind turbines cannot provide a reliable energy option for consumers because

A. they are costly to install and require constant maintenance.

B. the rotating blades of wind turbines are known to kill birds and bats.

C. the wind is an intermittent energy source and requires a backup energy source or storage option.

D. most wind turbine sites are in remote locations and the transfer of energy to consumers results in energy losses through transmission.

Question 23

Which one of the following is an effective method for the biological rehabilitation of an open-cut mine after ore extraction has ceased?

A. planting native vegetation to prevent erosion

B. filling the mine pit with water and stocking it with exotic fish

C. removing contaminated soil and vegetation permanently

D. adding limestone powder to neutralise acid mine drainage

Question 24

The negative impacts of open-cut mining can include loss of plant species, changes to run-off and loss of topsoil.

Which of the following identifies the Earth system involved in each open-cut mining impact?

	Open-cut mining impact		
	Loss of plant species	**Changes to run-off**	**Loss of topsoil**
A.	biosphere	hydrosphere	atmosphere
B.	hydrosphere	atmosphere	lithosphere
C.	biosphere	atmosphere	hydrosphere
D.	biosphere	hydrosphere	lithosphere

Question 25

An example of carbon sequestration that results in short-term changes in the carbon cycle is

A. absorption of carbon dioxide by trees and plants during photosynthesis.

B. carbon trapped in fossil fuels such as coal and oil.

C. carbon locked in limestone formations.

D. storage of carbon in deep ocean sediments.

Question 26

Which one of the following best explains how atmospheric gases regulate Earth's energy balance and climate through interactions with solar radiation?

A. Greenhouse gases absorb and re-radiate infrared radiation, trapping heat and contributing to the greenhouse effect.

B. Oxygen and nitrogen absorb most incoming solar radiation, preventing significant energy from reaching Earth's surface.

C. The atmosphere reflects all short-wave radiation and allows only long-wave radiation to pass through, maintaining Earth's temperature.

D. Solar energy is primarily absorbed by atmospheric gases before reaching Earth's surface, minimising its impact on surface temperatures.

Use the following information to answer Questions 27–30.

Turbidity is a measure of the cloudiness or muddiness of water. The greater the load of suspended particulates in water, the higher the turbidity. Turbidity can be recorded in nephelometric turbidity units (NTU).

A turbidity reading:

- under 10 NTU is rated as excellent (clear water with very low turbidity)
- between 17 and 36 NTU is rated as fair
- between 37 and 90 NTU is regarded as poor (muddy water with high turbidity).

Two groups of Environmental Science students collected turbidity measurements at the same six locations around a large lake in the same afternoon. Both groups used the same portable electronic turbidity meter to obtain their results. Group A measured the turbidity levels once at each of the six locations, while Group B measured the levels five times at each location and calculated a mean reading for each location. The NTU readings obtained by both groups are shown in the following table.

NTU readings at six locations

	Location					
	1	**2**	**3**	**4**	**5**	**6**
Group A readings (NTU)	22	20	25	9	29	27
Group B mean readings (NTU)	23	21	24	48	27	26

Question 27

Which one of the following statements about the data gathered by the groups is correct?

A. Group A and Group B have produced accurate data.

B. Group A has produced more precise turbidity results.

C. Group B can measure its precision from its raw data.

D. Group A and Group B have recorded the true value of turbidity levels.

Question 28

Which standardised quantity did the students use to measure turbidity?

A. six water samples

B. nephelometric turbidity units

C. cloudiness or muddiness level

D. portable electronic turbidity meter

Question 29

Why did Group B measure the turbidity levels five times rather than just once like Group A?

A. to produce a valid reading

B. to decrease the bias of the results

C. to reduce the effect of random errors

D. to demonstrate the randomness of the turbidity levels

Question 30

Based on the results given in the table, what would be a valid conclusion to the investigation into the water quality of the lake?

A. The lake has fair turbidity levels at all locations.

B. The turbidity levels do not vary at different locations around the lake.

C. The lake has poor turbidity levels and is quite muddy and not very clear.

D. The lake has fair turbidity levels in general, with one location having a poor level.

End of Section A

Section B

Instructions

- Answer **all** questions in the spaces provided.
- Write your responses in English.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (11 marks)

A group of Environmental Science students from Central Victoria aimed to measure the species diversity at their local park. They used one 2 × 2 m quadrat and counted the variety of species present. They found both exotic and native species, as shown in the table in **part a**.

a. Calculate Simpson's Index of Diversity (SID) for this sample in the spaces provided. 2 marks

Species	n_i	$n_i - 1$	$n_i(n_i - 1)$
exotic separated tussock grass	25	25 − 1 = 24	25(24) = 600
exotic bearded oatgrass	2	2 − 1 = 1	2(1) = 2
endemic rough spear grass	3	3 − 1 = 2	3(2) = 6
native housefly	2	2 − 1 = 1	2(1) = 2
native ant	2	2 − 1 = 1	2(1) = 2

N =
N(N − 1) =

$\Sigma[n_i(n_i - 1)]$ =

Therefore:

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

SID for the quadrat is ____

Do not write in this area.

b. Explain the difference between species richness and relative abundance with reference to the students' data. 3 marks

c. One of the students suggested that, based on this data, the park should become a protected area under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) treaty.

Evaluate whether this suggestion is justified. 3 marks

d. Another method used to measure species abundance is the mark-recapture technique.

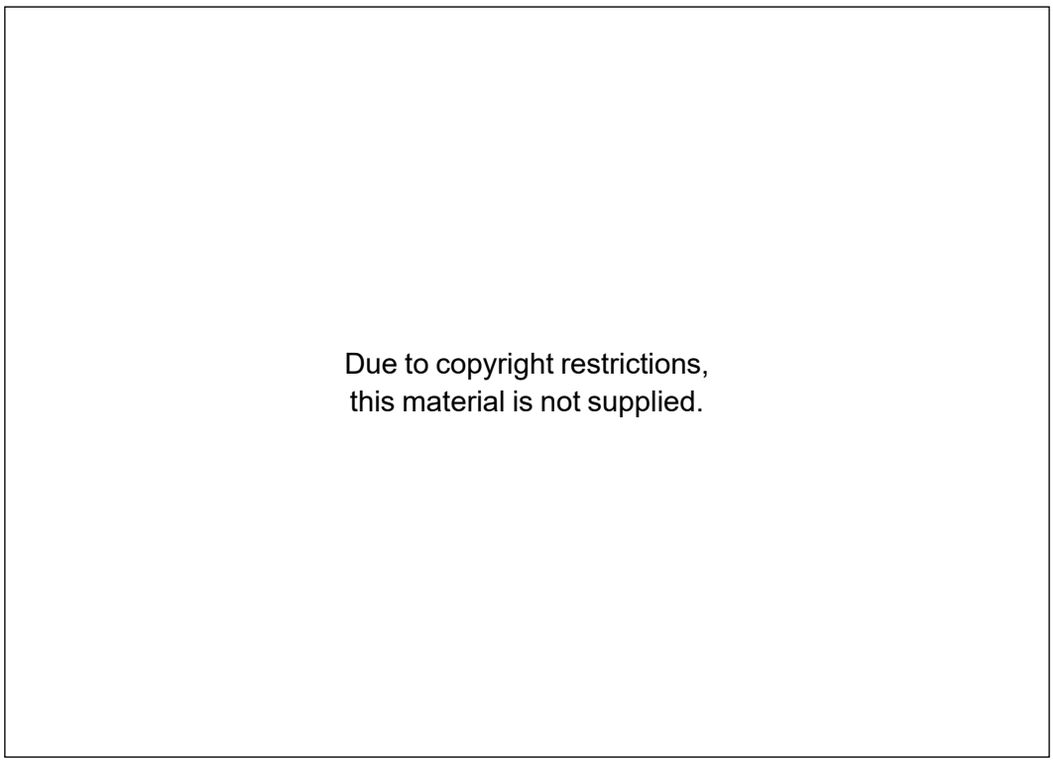
Discuss whether using the mark-recapture technique to measure the abundance of endangered native animals follows ethical guidelines. 3 marks

Question 2 (14 marks)

The southern pygmy perch (*Nannoperca australis*) has been successfully reintroduced to Bendigo Creek, where it was formerly locally extinct. This fish grows 6–8 cm in length and occupies wetland habitat, using dense reeds and driftwood for protection from predators and for breeding. These fish play a vital role in the Bendigo Creek ecosystem. They consume mosquito larvae, providing a natural method of pest control. They also act as a key food source for numerous native freshwater fish and waterbird species.

Local extinction of the Bendigo Creek perch population occurred during the mid-19th century. This was due to habitat loss and degradation, competition from invasive fish species, prolonged drought and excessive water extraction for agriculture.

Following the reintroduction of the southern pygmy perch in 2020, populations of this fish are now thriving in Bendigo Creek.



Source: iNaturalist, <www.inaturalist.org/taxa/209236-Nannoperca-australis>

a. The conservation status of the southern pygmy perch has recently been upgraded to 'near threatened' by the International Union for Conservation of Nature (IUCN).

State which conservation category the perch would most likely have belonged to **before** conservation efforts. 1 mark

b. Explain why competition from an invasive species is a threat to the perch. 2 marks

c. Two management strategies undertaken before the successful reintroduction of the perch to the area were restoration of habitat and captive breeding.

Describe an action that could have been taken in each strategy. 4 marks

Restoration of habitat

Captive breeding

d. Describe how the increasing perch population provides a regulating service for humans. Make the meaning of the term 'regulating service' clear in your response. 2 marks

Question 2 continues on the next page.

e. Conservationists performed genetic analysis of the perch population in 2022, two years after it had been reintroduced. They compared the genetic diversity of this population to that of the original population.

i. Using this example, explain why the conservationists collected data on the original population's genetic diversity. 2 marks

ii. Explain why the conservationists were interested in measuring the genetic diversity of the perch population after the reintroduction program. 3 marks

Question 3 (13 marks)

Ten years ago, a farming family bought an 8 hectare section of a former cattle property and converted it into an organic market garden. Their aim was to produce mainly herbs and vegetables, as well as native fruits and seeds.

This family now supplies produce to three local markets and several restaurants within a 10 km radius of the farm. The prices of their organic herbs, vegetables and fruits are higher than the prices for produce grown using conventional methods. However, the local community has supported the organic market garden because of its interest in native foods and the belief that the use of chemicals in food production can be harmful to health.

A creek runs along the northern boundary of the market garden. The land for the cattle property was cleared more than 150 years ago and, over time, this led to poor soil quality, erosion of the creek banks and a build-up of sediment in the creek. The productivity of the cattle farm declined. The farming family has worked with local environmental groups to revegetate the creek valley with endemic plants.

As organic farmers, the family has used a variety of natural methods to improve soil health, for example:

- using naturally occurring fertilisers such as green compost and animal manures (rather than industrially manufactured fertilisers)
- minimising water use to irrigate the plants
- implementing biological pest control methods (rather than using chemical pesticides)
- planting legumes, which add nitrogen to the soil.

a. Does the conversion to organic farming from cattle grazing demonstrate the sustainability principles of ‘efficiency of resource use’ and ‘intergenerational equity’? Justify your response by explaining the meaning of each term in the context of the development of the organic market garden from land previously used for cattle grazing. 4 marks

Question 3 continues on the next page.

b. Discuss the values and priorities that have influenced responsible decision-making by the farming family in the organic market garden's development. 2 marks

c. With reference to the change in land use from cattle grazing to organic market gardening, use the concept of cost-benefit analysis to complete the table below. Give one example for each blank cell in the table. 4 marks

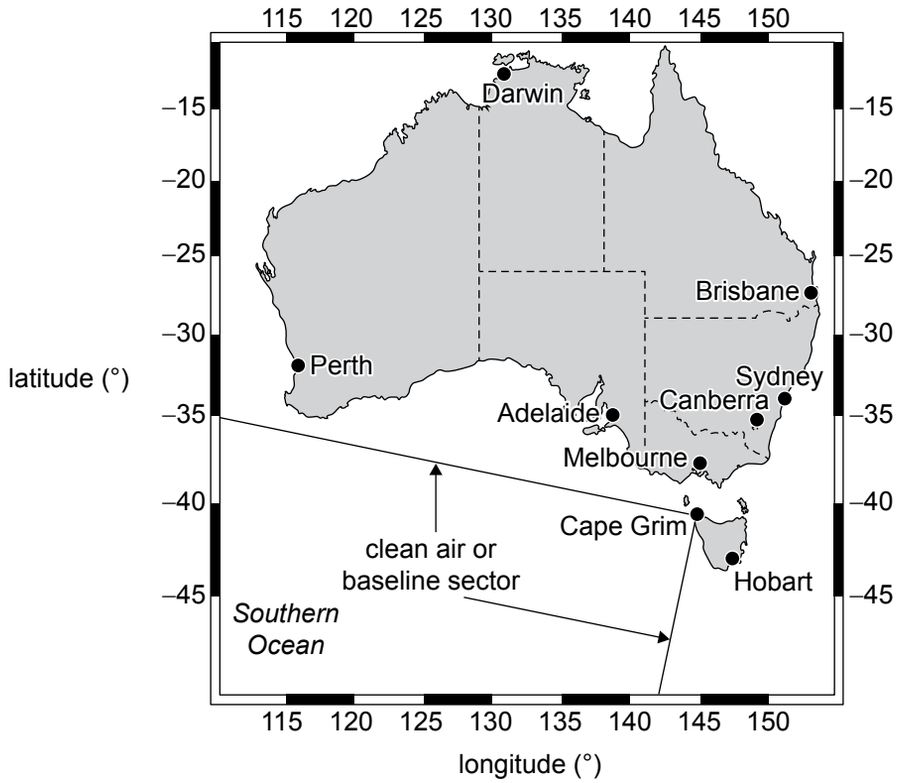
	Environmental	**Economic**
Cost		
Benefit		

d. A local restaurant owner suggests that, by setting up an organic market garden to grow and sell produce for the farming family's income, the family is demonstrating an anthropocentric focus.

Evaluate this viewpoint in the context of the change to land use at the organic market garden that has occurred over the 10 years. Make the meaning of the term 'anthropocentrism' clear in your response. 3 marks

Question 4 (14 marks)

The Kennaook/Cape Grim (KCG) air monitoring station is located on the north-west tip of Tasmania. The purpose of the KCG station is to take many individual measurements of key indicators of global air quality, such as greenhouse gases and ozone-depleting substances. The KCG station's unique location allows for local sources of pollution to be avoided by only taking measurements at times when winds blow in from across the Southern Ocean. Avoiding local pollution in this way allows for changes in global air quality to be measured over time.



Source: Adapted from Z Chen, R Schofield, M Keywood et al., 'Observations of the boundary layer in the Cape Grim coastal region: Interactions with wind and the influences of continental sources', *Remote Sensing*, 2023, vol. 15: 461

a. Explain how the sampling technique used at the KCG station ensures the validity of the data collected. Make the meaning of the term 'validity' clear in your response. 2 marks

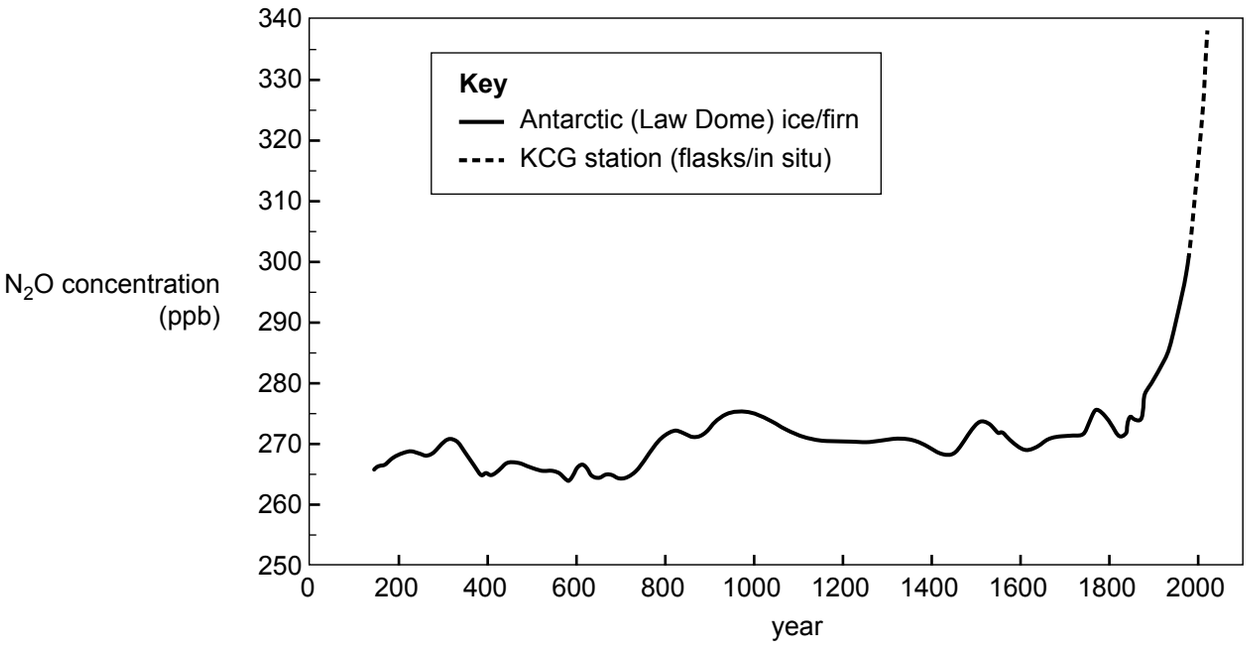
b. The average annual carbon dioxide concentration at the KCG station has increased from 329 ppm when records began in 1976 to 421 ppm at the end of 2024.

Calculate the percentage increase in carbon dioxide from 1976 to 2024. Show your working. 2 marks

Question 4 continues on the next page.

c. The KCG station also measures nitrous oxide, N_2O.

Atmospheric N_2O concentrations over 2000 years – observations/data taken from Antarctic ice cores and atmospheric readings at the KCG station



Source: Adapted from CSIRO, Nitrous oxide greenhouse emissions, <www.csiro.au/en/news/all/news/2024/june/>, © Bureau of Meteorology/CSIRO/Australian Antarctic Division

i. Referring to the graph, describe how the atmospheric levels of nitrous oxide have changed since 1800. 2 marks

ii. State what caused the changes in atmospheric nitrous oxide levels both before and after 1800. 2 marks

Before 1800 _____

After 1800 _____

Do not write in this area.

d. Nitrous oxide has a global warming potential of 273 over a 20-year period.

Describe what is meant by the term ‘global warming potential’ in relation to nitrous oxide. 2 marks

e. With reference to each of the relevant forms of radiation, outline how the natural greenhouse effect supports life on Earth. 4 marks

Question 5 (8 marks)

Cotton is one of Australia's most valuable exports, with 90% of cotton grown in Australia being sold overseas. Cotton is an annual crop, with the planting season usually beginning in September and harvesting in autumn. The flower of the cotton plant is harvested to produce fibres for clothing and other textiles.

Source: zcebeci/Shutterstock.com

Cotton has an optimal growing temperature of 28 °C ± 2 °C. Temperatures below 11 °C can negatively affect seedling growth. In addition, extreme high temperatures can cause flower loss, reducing crop yield.

Climate scientists are investigating the potential opportunities and risks of climate change for cotton farmers. In 2024, historical climate modelling found that between 1960 and 2020 there was:

- a decrease in the average number of early season cold shocks (<11 °C)
- a decrease in days from planting until first flowering
- an increase in average growing season temperatures
- an increase in the frequency of high-temperature days (>35 °C)
- an increase in evaporation and transpiration rates
- no significant change in seasonal rainfall.

Reference: K Broughton, C Nunn and M Bange, 'The here and now of climate change: Climatic trends throughout Australian cotton regions and implications for the growing season', *Field Crops Research*, vol. 315, 1 July 2024

a. The optimal growing temperature for cotton indicates a degree of uncertainty of ± 2 °C.

Describe what is meant by the term 'uncertainty' and what it suggests about the ideal growing temperature for cotton. 2 marks

Do not write in this area.

b. Based on the information provided, suggest **two** potential future risks to the cotton industry. 2 marks

c. The Northern Territory Government has been trialling cotton crop production in several regions. Over 9700 hectares of cotton were planted in the 2023–2024 growing season in the Northern Territory. A group of local Aboriginal people have expressed concerns about the change in land use of the area.

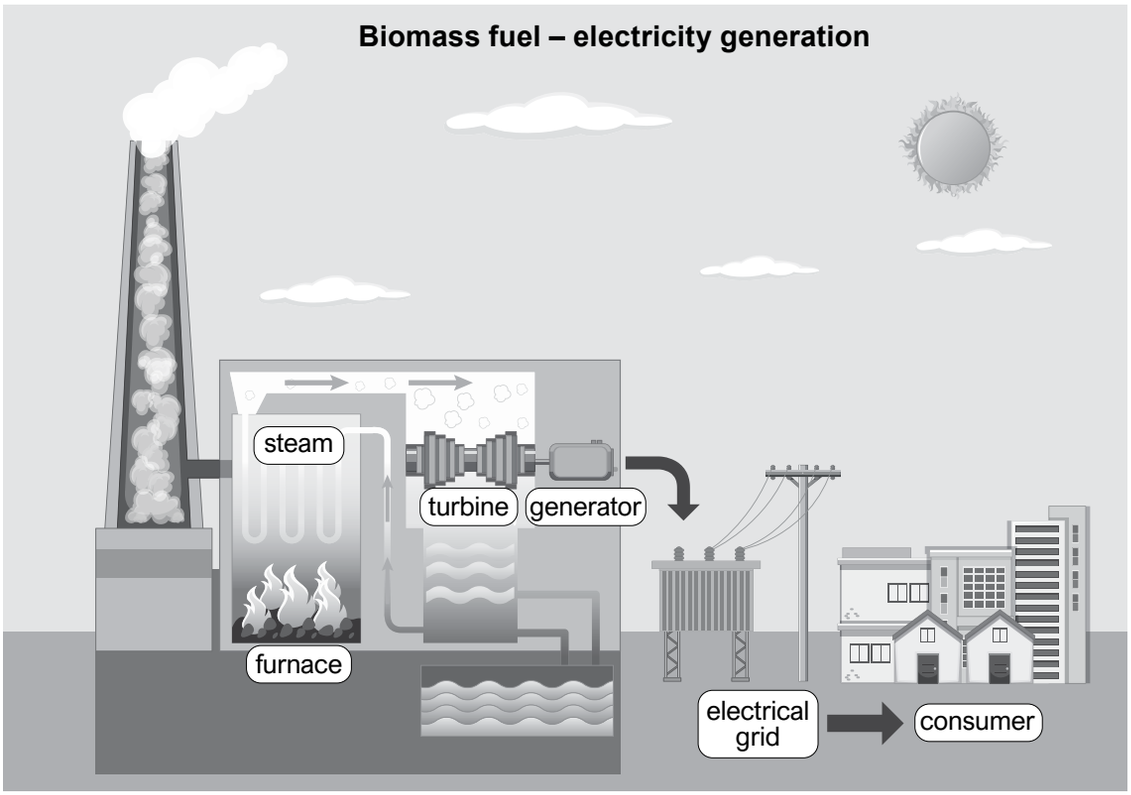
Explain the importance of Aboriginal people's perspectives in the Northern Territory Government's decision to allow cotton crop production to be trialled in the territory. 2 marks

d. In 2022, the Intergovernmental Panel on Climate Change (IPCC) indicated with high confidence that sustainable land management practices can contribute to reducing the negative impacts of climate change.

Outline what the IPCC's confidence rating suggests about the importance of sustainable land management practices for cotton growers. 2 marks

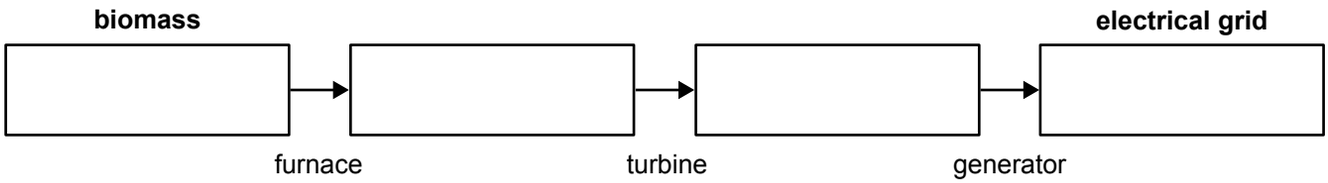
Question 6 (11 marks)

Cape Byron Power in New South Wales is one of Australia's largest commercial biomass energy suppliers. The company runs two 30 MW biofuel power plants, which mainly burn the waste products from wood residues and sugarcane milling. Energy crops, such as dedicated plantation forests, are also grown specifically for biomass fuel. Combined, the power plants supply sufficient energy to power approximately 60 000 homes.



Source: Adapted from BlueRingMedia/Shutterstock.com

a. In the boxes provided below, write the energy forms that show the transformations when biomass is combusted at a power plant to produce electricity. 2 marks



b. The biofuel used has an energy content of 15 MJ/kg. When 1000 kg of biofuel is burned, 5250 MJ of electricity is produced.

Calculate the efficiency of the biofuel power plant. Show your working. 2 marks

Do not write in this area.

c. Compare the environmental impact of using biomass energy to that of using coal in terms of the carbon cycle. 3 marks

d. Identify **one** risk of growing the energy crops for biomass fuel and describe the potential impact this might have on the local environment. 2 marks

e. The Northern Rivers region of New South Wales has a population of approximately 300 000 people.

Evaluate whether biomass energy is a suitable source to meet the base load energy requirements of this region. 2 marks

Question 7 (8 marks)

Proposals have been made to introduce the use of nuclear power in Australia. The plans include constructing several nuclear power plants across the country.

a. Circle the correct classifications for nuclear energy in terms of its source and renewability. 1 mark

Source	fossil fuel	non-fossil fuel
Renewability	renewable	non-renewable

b. Discuss the implications of using nuclear power as an energy source in terms of each of the following. 4 marks

Greenhouse gas emissions _____

_____

_____

_____

A reliable energy source _____

_____

_____

_____

c. It is claimed that nuclear energy will provide cheaper energy to the consumer due to lower running costs across the working life span of a nuclear reactor. A small nuclear reactor can produce the same amount of electricity as a large wind farm – approximately 300 MW.

The table below gives data regarding the costs involved in building and operating a nuclear reactor and a wind farm across their working life spans.

	Nuclear reactor	**Wind farm**
Approximate power output (MW)	300	300
Building cost ($)	5000 million	500 million
Annual operating cost ($)	600 million	450 million
Life span (years)	80	20

Source: Adapted from Australian Parliament House, <www.aph.gov.au> and CSIRO, <www.csiro.au>

i. Use the data provided to calculate and compare the overall cost of each form of power generation over 80 years. 2 marks

ii. Apart from the factors considered in **parts a**, **b** and **c.i**, state a factor that could be considered when evaluating nuclear power against wind generation. 1 mark

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Question 8 (11 marks)

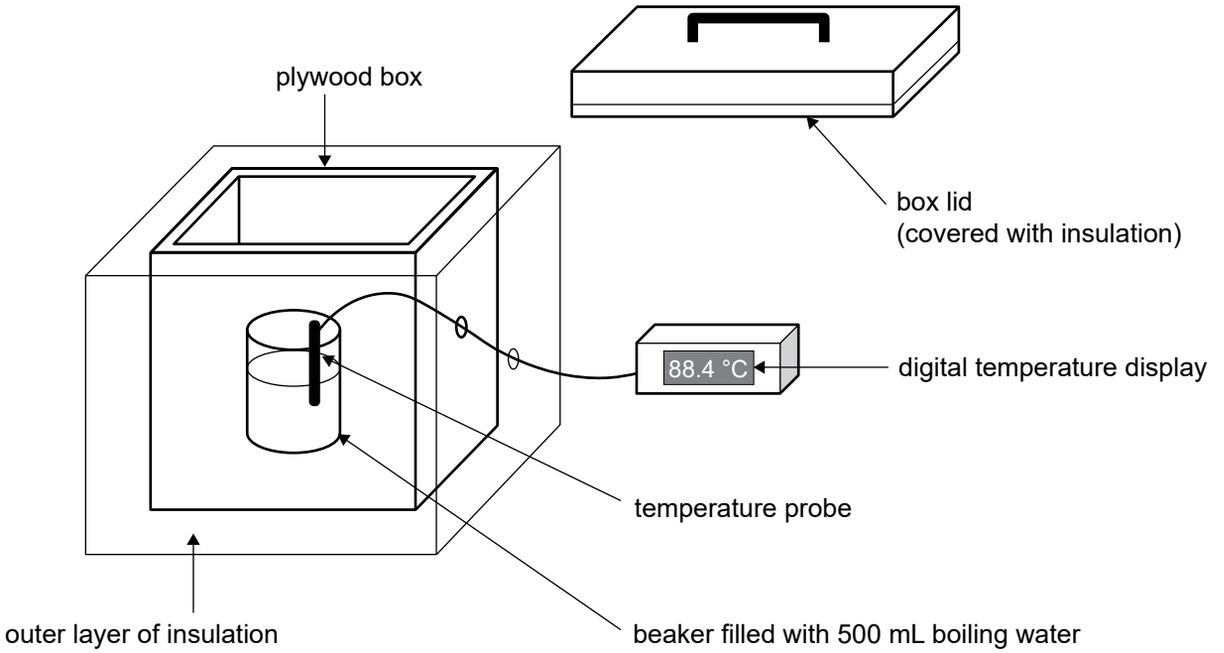
Insulation is a material that can be used to block or slow the flow of heat into and out of a house, keeping it warmer in winter and cooler in summer. Insulation materials are given an R value, which is a measure of the rate of heat loss or gain. The higher the R value, the better the material insulates.

A class of students wanted to compare five insulation materials. They were provided with R values from manufacturers. They obtained five identical boxes made of plywood with tightly fitting, removable lids. They attached pieces of insulation of equal thickness to the sides and bottoms of each box, including the lid, but left one box without any insulation coverage.

The following table provides information about the different insulation materials that were used by the students in the experiment.

Box number	Insulation material	Known R value of material used in experiment
1	plain plywood box (no additional insulation material)	0.1
2	fibreglass batt	1.4
3	natural wool batt	2.2
4	rockwool batt	1.1
5	polystyrene board	1.6

Inside each of the five boxes, the students placed a beaker containing 500 mL of water that had just boiled. They then inserted the temperature probe into the water (attached by a wire to a digital temperature display outside the box) and immediately placed the lid on each box. The diagram below shows the experimental set-up.



The students plan to record the temperature of each beaker of water at the start of the experiment and then every 2 minutes for a total of 30 minutes.

a. State a suitable hypothesis for the experiment conducted by the students. 2 marks

b. Identify the dependent variable for this experiment. 1 mark

Question 8 continues on the next page.

c. Predict which of the five boxes would lose the most amount of heat over the 30 minutes. Justify your response. 2 marks

d. Identify a systematic error associated with the use of a temperature probe and suggest how this error could be prevented. 2 marks

e. Explain why the use of insulation materials with a higher R value in houses helps reduce personal energy consumption. 2 marks

f. A builder plans to renovate a home that already has some roof and wall insulation.

Suggest how the builder could maximise the insulation efficiency of the home in terms of heating and cooling. 2 marks

End of Question and Answer Book

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