Neap

VCE Environmental Science Units 3&4

Question and Answer Booklet

2024 Trial Examination

Reading time: 15 minutes

Writing time: 2 hours

Student's Name: _____

Teacher's Name: _____

Materials supplied

- Question and Answer Booklet of 27 pages
- Multiple-Choice Answer Sheet

Instructions

- Write **your name** and your **teacher's name** in the spaces above on this page.
- 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 booklet.

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

Contents pages

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2024 VCE Environmental Science Units 3&4 Examination.

Section A – Multiple-choice questions

Instructions

- Answer **all** questions in pencil on the 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 booklet are **not** drawn to scale.

Question 1

Introduced species such as the fallow deer (*Dama dama*) can cause significant damage to native ecosystems. The fallow deer impact native ecosystems by causing soil erosion, damaging fragile native plant species and spreading weeds.

How might this threaten biodiversity in areas where fallow deer are introduced?

A. Native animal species may experience increased habitat options due to the spreading of weeds.

B. Native plant species may experience increased competition for space and nutrients.

C. The populations of fallow deer may face inbreeding due to the limited available space for breeding.

D. Soil erosion may impact native fish species via biomagnification.

Question 2

Which one of the following best describes a way to measure a particular species' genetic diversity?

A. The variety of genes, alleles and inherited characteristics carried by all species on Earth.

B. The relative abundance of one species in two different locations.

C. The variety of genes, alleles and inherited characteristics carried by one species.

D. The relative abundance of healthy ecosystems in two different biomes.

Question 3

Ecosystem services are benefits gained by humans from healthy functioning ecosystems.

Which one of the following best describes the difference between supporting and regulating services?

A. Supporting services are more important to humans than regulating services.

B. Supporting services only occur in marine ecosystems, whereas regulating services can occur in marine and terrestrial ecosystems.

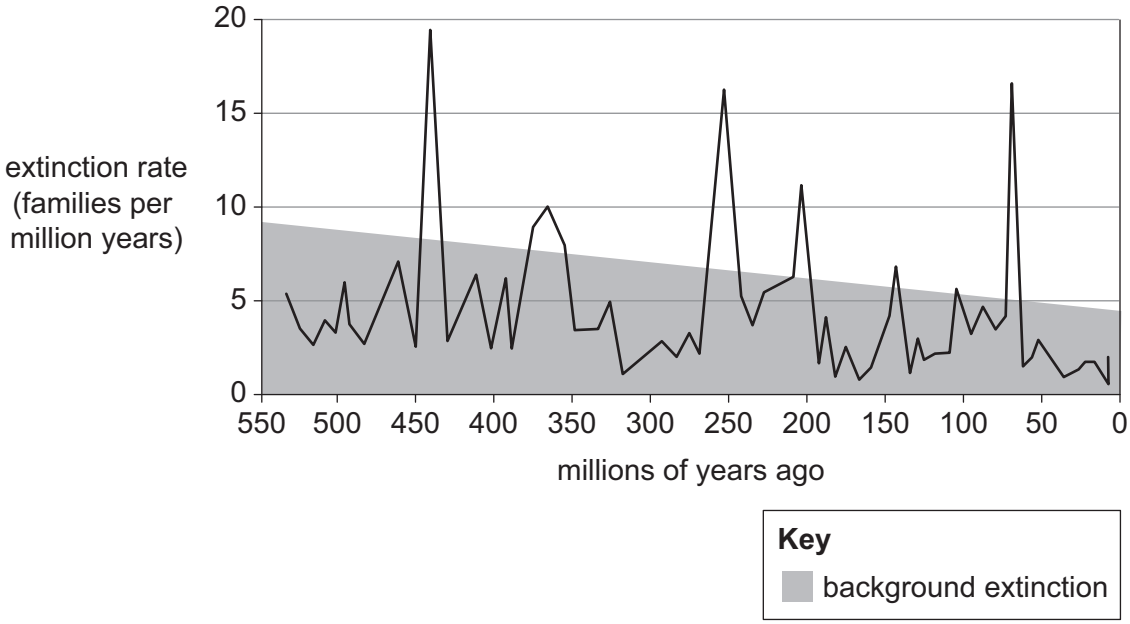
C. Supporting services include the provision of food and medicine for humans, whereas regulating services include the pollination of crops to grow food and medicine.

D. Supporting services maintain conditions for life on Earth, whereas regulating services regulate and control ecosystem processes.

Use the following information to answer Questions 4 and 5.

The following graph shows the extinction rate of species on Earth over time. The shaded area shows background extinction rates, which are the average extinction rates without human intervention over time.

Extinction rate of species over time



Source: Modified from Our World in Data (2022), '"Big Five" Mass Extinctions in Earth's History'. Accessed May 2024. https://ourworldindata.org/mass-extinctions. Licensed under CC BY 4.0, https://creativecommons.org/licenses/by/4.0/legalcode.en.

Question 4

It is important to consider background extinction rates when discussing changes in biodiversity over time because it

A. provides qualitative data that can be used to explain biodiversity loss.

B. shows exactly which species are most at risk of current day extinction.

C. provides baseline data to act as a comparison when studying the impacts of anthropogenic factors on extinction rates.

D. proves that mass extinctions can occur due to anthropogenic factors.

Question 5

Background extinction is calculated by

A. using the fossil record to identify the number of distinct species that existed and those that became extinct.

B. using ice core samples to identify past atmospheric conditions that may have been unfavourable for species to survive in.

C. measuring the Simpson's Index of Diversity of multiple sites around Earth.

D. using the fossil record to identify the species that became extinct during the first mass extinction.

Use the following information to answer Questions 6–8.

In March 2023, the Eastern Maar people won the legal case for native title rights for an area of south-western Victoria, including the Great Otway National Park. The Great Otway National Park is home to the spotted-tail quoll (*Dasyurus maculatus*), which is listed as endangered under the *Flora and Fauna Guarantee Act 1988* (Vic).

Question 6

Which one of the following best describes the protection the spotted-tail quoll receives under the *Flora and Fauna Guarantee Act 1988* (Vic)?

A. The spotted-tail quoll is legally protected from harm in all of Australia.

B. The spotted-tail quoll is legally protected from harm in all of Victoria.

C. The Eastern Maar people have a legal responsibility to protect the spotted-tail quoll.

D. All tourism in the Great Otway National Park is monitored to ensure the protection of the spotted-tail quoll.

Question 7

If the spotted-tail quoll's population numbers continue to decrease, which one of the following conservation categories will it be listed under?

A. critically endangered

B. near threatened

C. vulnerable

D. least concern

Question 8

Native title rights recognise the rights of the Eastern Maar people to protect the land and preserve areas of cultural importance for future generations.

Which sustainability principle does this recognition meet?

A. user pays principle

B. intragenerational equity

C. intergenerational equity

D. efficiency of resource use

Use the following information to answer Questions 9–11.

The Tarkine wilderness region covers 450 000 hectares of land in northwest Tasmania and includes some of Australia's oldest temperate rainforests. In 2022, the Australian Government granted permission for a mining company to construct a tailings dam to store mining waste as part of a mining project within the Tarkine region. Environmental activist groups challenged the project in the Supreme Court, stating that there was insufficient proof that the project would not cause any harm to the endemic Tasmanian masked owl.

Question 9

In this scenario, the precautionary principle is triggered because

A. there is insufficient proof that the project will not cause any harm to the Tasmanian masked owl.

B. the Tarkine region includes some of Australia's oldest temperate rainforests.

C. the mining company is constructing a mine and tailings dam in a wilderness region.

D. environmental activist groups challenged the project in the Supreme Court.

Question 10

Which value system does the mining company most likely hold?

A. biocentrism

B. anthropocentrism

C. ecocentrism

D. sociocultural

Question 11

Tailings dams can cause environmental damage through the leakage of heavy metals and toxic waste products into nearby rivers or soil.

Which of Earth's systems does this leakage harm?

A. atmosphere, hydrosphere and biosphere only

B. hydrosphere and atmosphere only

C. biosphere, hydrosphere and lithosphere only

D. atmosphere, biosphere, hydrosphere and lithosphere

Question 12

Environmental water allocations provide consumers with water while conserving the health of rivers and wetlands.

Which one of the following outlines a possible economic benefit of environmental water allocations?

A. They limit the amount of water available for agricultural production.

B. They help to maintain ecosystems of animals and plants living in water catchments.

C. They improve recreation options for residents by maintaining healthy rivers.

D. They provide long-term agricultural support by balancing water usage.

Question 13

In November 2023, Victoria's Container Deposit Scheme (CDS Vic) was introduced. CDS Vic refunds 10 cents for each aluminium can, plastic bottle or glass bottle returned to a CDS Vic refund point. The materials are then sorted and recycled into new products.

CDS Vic is demonstrating circular economy thinking because

A. consumers are paid for their used products.

B. waste is recycled.

C. the outputs of one product are used to create the inputs of another product.

D. both plastic and glass products are being accepted for payment.

Question 14

Which one of the following statements is true of the enhanced greenhouse effect?

A. Ultraviolet radiation impacts atmospheric temperature levels on Earth.

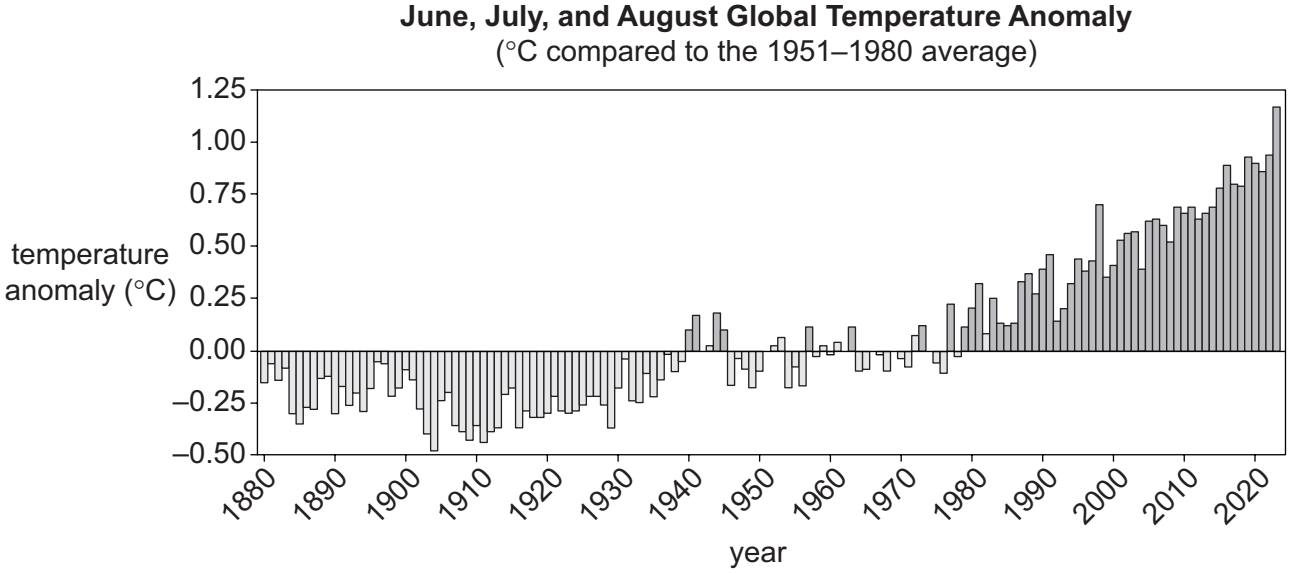
B. Visible light is absorbed by greenhouse gases before it reaches Earth.

C. Excess infrared radiation is absorbed and re-emitted by greenhouse gases in the troposphere.

D. Visible light increases ocean temperatures via the albedo effect.

Use the following information to answer Questions 15 and 16.

In September 2023, NASA reported that the Northern Hemisphere's summer of 2023 was Earth's hottest since global records began in 1880. The graph below shows global temperature anomalies over time, as compared to the average temperature between 1951 and 1980, which is used as the baseline.



Source: Reproduced from National Aeronautics and Space Administration (NASA) (2023). 'Summer 2023 Was the Hottest on Record'. Accessed May 2024. https://earthobservatory.nasa.gov/images/151831/summer-2023-was-the-hottest-on-record.

Question 15

Which one of the following reasons for this warming trend is most likely?

A. Shady regions on Earth have decreased due to deforestation.

B. Water vapour in the atmosphere has decreased due to increased evaporation.

C. Methane emissions have increased due to livestock agriculture.

D. Carbon emissions have increased due to the burning of fossil fuels.

Question 16

From the information in the graph between 1940 and 2020 it can be concluded that

A. global temperatures have been trending upward since the early 2000s.

B. Earth almost had an ice age in the 1900s.

C. there was no reason to gather global temperature data before 1980.

D. from 1940 to 1980, the average global temperature was 0°C.

Question 17

One unit of nitrous oxide has a greenhouse gas warming potential of 265 and one unit of sulfur hexafluoride has a greenhouse gas warming potential of 23 500.

This means that 1 tonne of

A. nitrous oxide will absorb 265 times more energy than 1 tonne of sulfur hexafluoride.

B. sulfur hexafluoride will absorb 23 500 times more energy than 1 tonne of nitrous oxide.

C. nitrous oxide will absorb 23 500 times more energy than 1 tonne of carbon dioxide.

D. sulfur hexafluoride will absorb 23 500 times more energy than 1 tonne of carbon dioxide.

Question 18

Which one of the following statements about ocean circulation is correct?

A. warm water is cooled at the equator before rising to the surface

B. cold water is warmed at the equator before rising to the surface

C. warm surface currents discontinue movement when they reach the equator

D. cold, deep water currents discontinue movement when they reach the poles

Question 19

Which one of the following is a biological technology used to reduce atmospheric carbon dioxide levels?

A. electric vehicles

B. carbon capture and storage

C. large-scale algae farms

D. ethanol production

Question 20

Climate modelling is limited due to the complexity of factors that impact global climate.

Which one of the following could lead to higher confidence levels in climate projections?

A. collecting multiple pieces of data from a single year

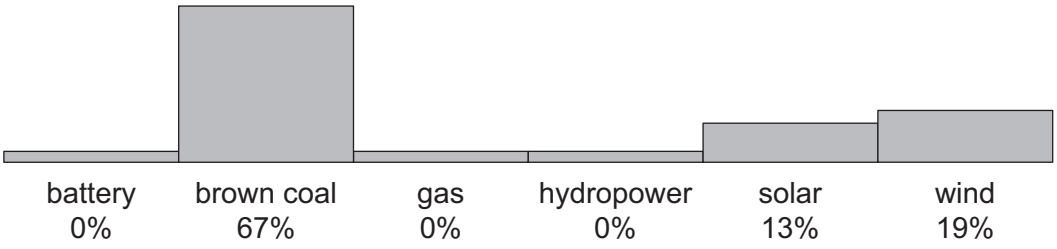
B. collecting multiple pieces of data from multiple years

C. collecting a single piece of data from a single year

D. collecting a single piece of data from multiple years

Use the following information to answer Questions 21 and 22.

The graph below shows the breakdown of energy sources used to produce electricity in Victoria in January 2024.



Source: Reproduced from AEMO (2024). 'NEM data dashboard'. Accessed May 2024. https://aemo.com.au/en/energy-systems/electricity/national-electricity-market-nem/data-nem/data-dashboard-nem.

Question 21

If Victorians consumed 95 petajoules of electricity in January 2024, how much of this electricity was produced using solar energy?

A. 7.30 petajoules

B. 12.35 petajoules

C. 13 petajoules

D. 1235 petajoules

Question 22

Which one of the following strategies could be employed to decrease Victoria's reliance on brown coal to produce electricity?

A. an increase in electric vehicle imports

B. a government-initiated reduction in the cost of solar photovoltaic panels

C. an increase in funding allocated to the mining sector

D. a reduction in the number of wind turbines in Victoria

Question 23

Which one of the following best describes the first law of thermodynamics?

A. All energy on Earth is provided by the Sun.

B. Energy can neither be created nor destroyed.

C. All energy conversions are inefficient.

D. Energy is lost as heat during all energy conversions.

Question 24

Biofuels are derived from biomass and can be used to power vehicles.

Biofuels are produced from

A. non-fossil fuels and are a non-renewable resource.

B. non-fossil fuels and are a renewable resource.

C. fossil fuels and are a non-renewable resource.

D. fossil fuels and are a renewable resource.

Question 25

Due to an increase in the use of natural gas for heating and cooking, global methane emissions have increased from 21.3 million tonnes in 2000 to 36.7 million tonnes in 2022 (IEA, 2023).

What was the percentage increase in global methane emissions between 2000 and 2022?

A. 11%

B. 15%

C. 58%

D. 72%

Question 26

Which one of the following forms of energy is **not** involved in the production of electricity using uranium?

A. kinetic thermal energy

B. kinetic mechanical energy

C. nuclear potential energy

D. gravitational potential energy

Use the following information to answer Questions 27–30.

In agriculture, hydrogels are products that can be added to soils to assist with water retention.

A group of Environmental Science students investigated the water retention ability of various biodegradable hydrogels when added to soil as part of an agricultural project. The students made three different hydrogels using various ingredients, as shown in the table below.

They set up four plastic pots in a temperature-controlled greenhouse and filled each pot with 4.5 litres of potting mix. One of the three hydrogels was added to the soil in pots 1–3. The students measured the mass of each pot before adding 100 ml of water to each pot. They then measured the mass of each pot every day for 14 days. The experiment was repeated five times.

Pot number	Hydrogel ingredients
1	agar powder, citric acid
2	hydroxyethyl cellulose powder, citric acid
3	agar powder, hydroxyethyl cellulose powder, citric acid
4	–

Question 27

Which one of the following is a controlled variable in this experiment?

A. the mass of each pot after adding 100 ml of water

B. the type of hydrogel

C. the volume of potting mix

D. the mass of each pot after 14 days

Question 28

Which one of the following situations could have led to a systemic error in this experiment?

A. Using uncalibrated scales to measure the mass of each pot.

B. Placing the pots on a different part of the scales' weighing plate each time they were measured.

C. Estimating 4.5 litres of potting mix by filling each of the plastic pots to the top for each trial.

D. Incorrectly measuring the amount of water that was added.

Question 29

Which one of the following would have improved the validity of the students' experiment?

A. collecting data over a period of 14 days

B. investigating three different types of hydrogels

C. controlling multiple variables such as the volume of water and potting mix and the location of the pots

D. repeating the experiment five times

Question 30

Which one of the following describes an ethical consideration of this experiment?

A. The students considered an appropriate disposal of the hydrogels and potting mix after the experiment was complete.

B. The students asked their teacher for permission to access the temperature-controlled greenhouse.

C. The students wore gloves when handling the hydrogel ingredients and potting mix.

D. The students considered the uncertainty in their measurement equipment and reported this in their final report.

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 booklet are **not** drawn to scale.

Question 1 (12 marks)

Eagle Rock Marine Sanctuary covers 17.9 hectares of intertidal zone in Wadawurrung country, Aireys Inlet, Victoria. In 2002, as a result of biodiversity studies, the area was declared a marine sanctuary to conserve biodiversity and ecological processes for future generations. In 2010, a new study was conducted by Deakin University to assess the biodiversity of the area and the impacts of human recreational activities.

As part of the study, a transect was positioned from the upper shore to the low tide mark and species that appeared on each side of the transect were recorded at 1-metre intervals. Transects were placed in 5-metre increments along the length of the marine sanctuary area.

The Simpson's Index of Diversity (SID) and species richness were calculated and compared with the data collected prior to the area being declared a marine sanctuary. Data on factors such as relative abundance, human recreational activities and rock structures were also recorded.

The study found that after the area was declared a marine sanctuary, the SID and species richness of the area had both increased, and relative abundance was more evenly distributed.

a. Explain how data on relative abundance could have impacted the SID calculation of the area. In your response, make clear the meaning of the term 'relative abundance'. 2 marks

b. Explain the conclusion that can be drawn from the statement 'after the area was declared a marine sanctuary, the SID and species richness of the area had both increased'. 3 marks

c. **i.** Name **one** piece of equipment that could have been used in addition to transects to improve the precision of this study. 1 mark

ii. Describe how the piece of equipment named in **part c.i.** could be used to improve the precision of this study. 2 marks

iii. Explain why using transects is the most appropriate method for a study of rocky reef ecosystems. 2 marks

d. Explain why collecting qualitative data about activities such as human recreational activities was important to studying the biodiversity of Eagle Rock Marine Sanctuary. 2 marks

Question 2 (11 marks)

The Wrinkled Buttons (*Leiocarpa gatesii*) is a small herbaceous plant endemic to a small area of the Victorian coastline between Anglesea and Lorne, where an estimated 10–15 populations remain. The plant is found in hilly regions of open eucalypt forests and studies suggest that the plant sprouts more frequently after fire and soil disturbance.

The main threats to the Wrinkled Buttons are inconsistent fire management schemes, weed invasion and track maintenance by Parks Victoria staff.

Source: Reproduced with permission from MacDonald, Margaret (n.d.). 'Wrinkled-Buttons'. Accessed May 2024. https://angairnatureshow.org.au/themes/protect/threatened-species/.

a. Explain why inconsistent fire management schemes are a threat to the Wrinkled Buttons.

2 marks

b. Explain **one** reason why low population numbers would threaten the Wrinkled Buttons.

2 marks

c. In terms of conservation, explain what it means that the Wrinkled Buttons is endemic to this small area of the Victorian coastline. In your response, make clear the meaning of the term 'endemic'. 2 marks

d. One management strategy currently used in the conservation of the Wrinkled Buttons includes acquiring thorough baseline population data.

Explain how this strategy may help to conserve the species. 2 marks

e. The Royal Botanic Gardens in Victoria are storing seeds in their Conservation Seedbank from targeted populations of the Wrinkled Buttons.

Explain why this could be a suitable strategy for the future population growth of the Wrinkled Buttons. 2 marks

f. The Wrinkled Buttons is listed as critically endangered in the *Flora and Fauna Guarantee Act 1988* (Vic) but it is not listed on the IUCN Red List of Threatened Species.

Outline the reason for this. 1 mark

Question 3 (14 marks)

A disused open-cut coal mine is located in a small coastal town near a highly biodiverse region of Victoria. The mine was in operation for 47 years and utilised water from a nearby underground aquifer to cool its mining equipment. As part of the cooling process, the mine also released water into a small river system.

As the river was naturally fed by the aquifer, when closing down its operations, the mine should have allowed the river system to return to its natural flow. However, as part of the mine rehabilitation plan, the 100-hectare mine pit was to be filled with water pumped from the aquifer. This process has led to low water levels in the river as well as highly acidic pH levels, impacting the biodiversity of the river.

An international ecotourism organisation has recently proposed constructing an ecotourism park on the site. The project would involve constructing a nature park and a domed indoor biosphere. This would allow the park to utilise the disused mine pit with its current water levels for the creation of an artificial freshwater ecosystem, therefore negating the need to continue pumping water from the aquifer.

The ecotourism organisation's proposal also states that 1300 jobs will be created and $350 million will be generated within 10 years of the parks' operation. Local environmentalist groups are concerned about the impact that constructing the park will have on the surrounding bushland and its organisms. Local water management groups also state that although the mine pit's water levels can be used as they currently are, the park itself will require large volumes of water to maintain the artificial freshwater ecosystem.

a. With reference to the sustainability principle of conservation of biodiversity and ecological integrity, justify whether this project should be approved. 3 marks

b. Describe how a qualitative risk analysis may be used in the decision-making process of this project proposal. 3 marks

c. Explain how intragenerational equity may be impacted if this project is approved. 2 marks

d. The town's local council plans to conduct a cost–benefit analysis of the project proposal, which will include an evaluation of sociocultural factors.

In the table below, identify **two** costs and **two** benefits that the local council may consider. 4 marks

Sociocultural factors	
Costs	**Benefits**

e. Explain why the Traditional Owners of this region would need to be consulted on this project. 2 marks

Question 4 (11 marks)

Nannochloropsis oculata is a species of microalgae that can be farmed on a large scale to provide an alternative omega-3 dietary supplement to fish oil. When processed, this microalgae can also be used to produce animal feed; as an ingredient in cosmetics and pharmaceuticals; and as biodiesel.

Microalgae gain energy through the process of photosynthesis. During this process, very little waste is produced.

Large-scale microalgae farms are currently operating in Queensland, as well as in parts of Europe and the USA.

a. Name the greenhouse gas that is used in the process of photosynthesis. 1 mark

b. Describe the effect that large-scale microalgae farming may have on the carbon cycle. 3 marks

c. Explain how large-scale microalgae farming could impact global temperatures. 3 marks

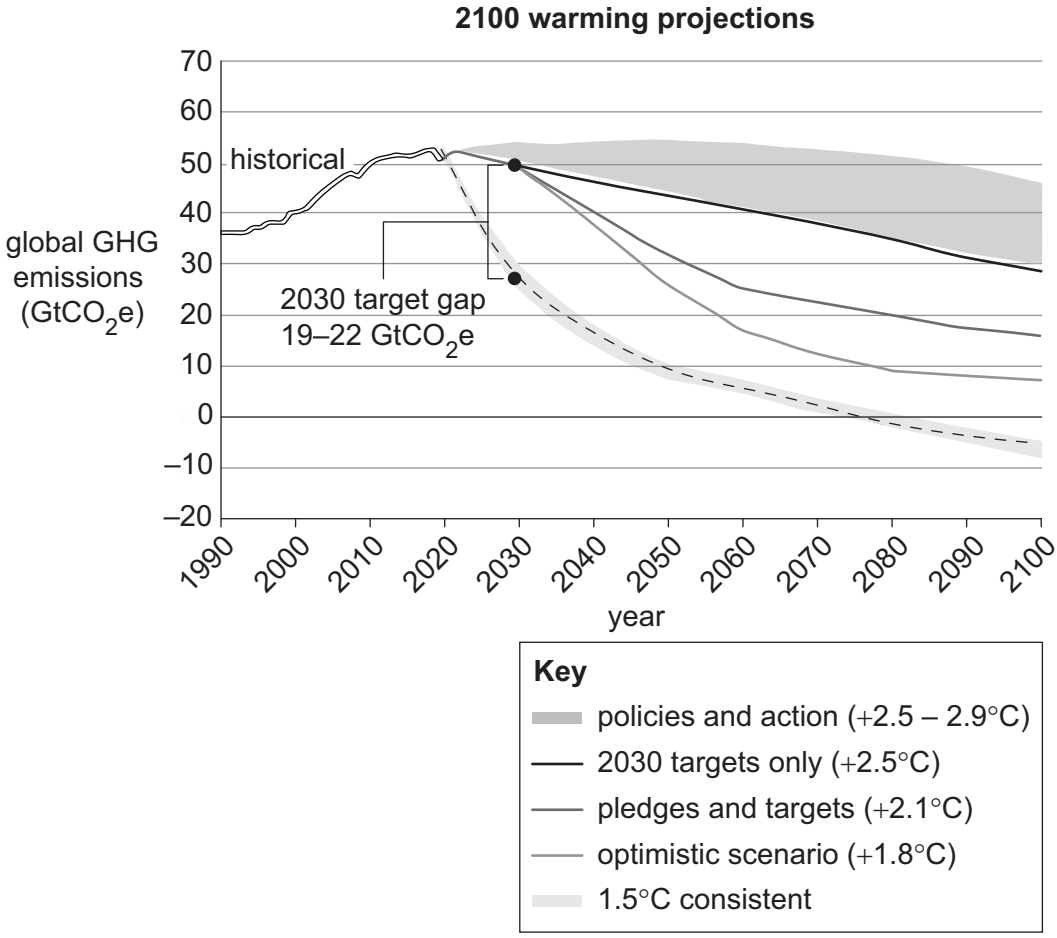
d. High water consumption is a common issue with large-scale microalgae farming.

Suggest **two** methods for sourcing **or** using water sustainably to ensure that large-scale microalgae farms maintain a low water footprint. 2 marks

e. Explain how large-scale microalgae farming could impact intergenerational equity. 2 marks

Question 5 (9 marks)

The following graph shows the projected increases in global temperature based on changes in global greenhouse gas emissions.



Source: Reproduced with permission from Climate Analytics and NewClimate Institute Climate Tracker (2023). 'Temperatures'. Accessed May 2024. https://climateactiontracker.org/global/temperatures/.

a. Calculate the percentage increase in historical global greenhouse gas emissions from 1990 to 2020. Show your working. 2 marks

b. Deduce **one** conclusion that can be drawn from the data in the graph above. 2 marks

c. Explain why the graph on page 21 shows a range of projections. 2 marks

d. Name **one** stakeholder with an ecocentric value system who may have been involved in the data collection for these projections. 1 mark

e. The sex of the critically endangered hawksbill sea turtle (*Eretmochelys imbricata*) is determined by the external temperatures of their eggs. Warmer temperatures produce female hatchlings, while cooler temperatures produce male hatchlings.

Current studies suggest that increases in global temperatures could cause a 2°C increase in nesting site sand temperatures.

Describe the impact of these temperature projections on hawksbill sea turtle populations. 2 marks

Question 6 (10 marks)

The Victorian Government has recently announced that the use of natural gas in homes will be phased out as an action to move towards net zero carbon dioxide emissions by 2050. As a result, all new homes in Victoria must include electric cooking and heating appliances.

a. Describe how natural gas is formed. 3 marks

b. Describe the energy conversions involved in the process of using natural gas for cooking or heating appliances. 2 marks

Brown coal is one of the main resources used to produce electricity in Australia and is most commonly mined in Victoria.

c. Compare the greenhouse gas emissions caused by extracting natural gas with those caused by extracting brown coal. 2 marks

d. Explain how the Victorian Government's plan to phase out gas will reduce carbon dioxide emissions. 3 marks

Question 7 (9 marks)

The construction of a solar farm in regional northern Victoria has recently been approved. The solar farm will cover 713 hectares of land that was originally used for livestock grazing. The solar farm will produce an annual energy output of 761 567 MWh via photovoltaic cells and will include a large-scale battery energy storage system.

a. Describe how photovoltaic cells are used in electricity production and distribution to consumers. 3 marks

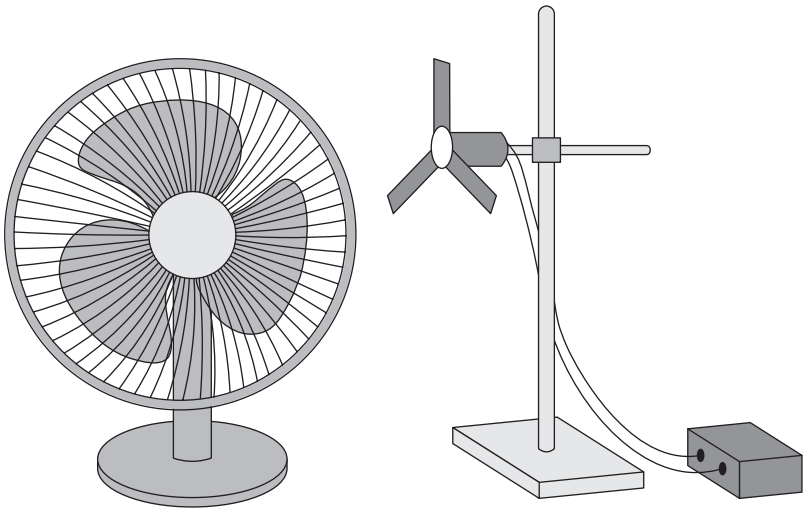
b. If solar energy is 20% efficient, calculate, in MWh, the annual energy input to the solar farm. Show your working. 2 marks

c. Explain how the annual energy input calculated in **part b.** demonstrates the secondlaw of thermodynamics. In your response, make clear the meaning of the second law of thermodynamics. 2 marks

d. Describe **one** environmental cost associated with the solar farm's construction. 2 marks

Question 8 (14 marks)

Two Environmental Science students, Jamie and Sarah, conducted an experiment to investigate how the number of blades in a wind turbine impacts the amount of electricity generated by the turbine. They used a model wind turbine kit from the science laboratory at their school; an electric fan to provide 'wind'; and a multimeter set to 'volts' to measure the amount of electricity generated by the wind turbine. The experiment set-up is shown in the diagram below.



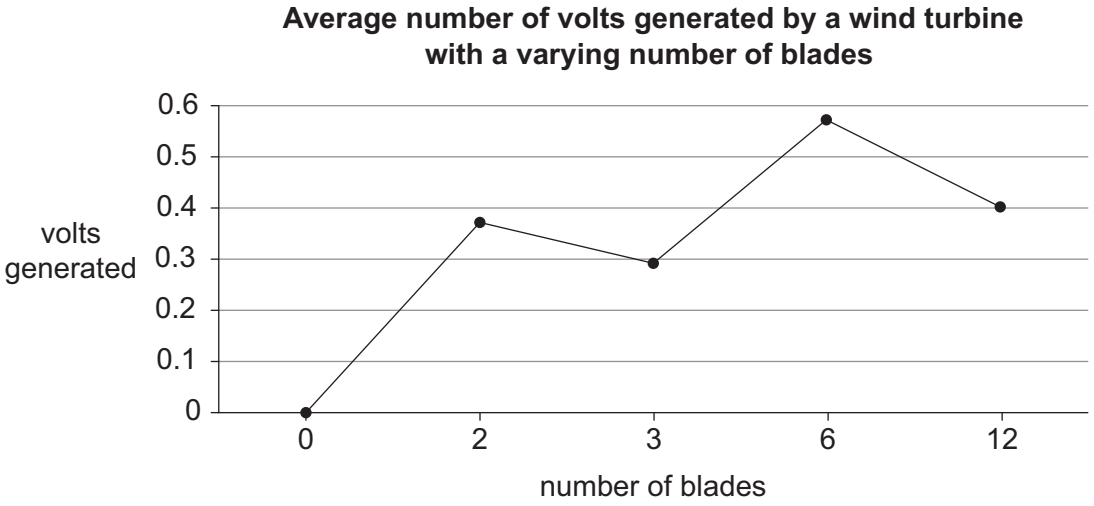
fan | model wind turbine kit | multimeter

The students hypothesised that a greater number of blades on the turbine would generate more volts.

The students used the following methodology.

- A model wind turbine kit was constructed using a retort stand and connected to a multimeter, as shown in the diagram above.
- Five tests were conducted. The first test used 0 blades (the centre rotor only); the second test used 2 blades; the third test used 3 blades; the fourth test used 6 blades; and the fifth test used 12 blades.
- The distance between the fan and the wind turbine, the height of the wind turbine, the length of the blades and the fan speed were kept consistent.
- The fan was set to the highest speed and allowed to run for 60 seconds during each test before the number of volts was read from the multimeter.
- The number of volts was recorded for each of the five tests conducted.
- Each of the five tests was repeated three times, and the average number of volts for each experimental group was calculated.

The data that Jamie and Sarah collected is shown in the graph below.



a. **i.** Identify the independent variable. 1 mark

ii. Identify the dependent variable. 1 mark

b. Suggest **one** reason for the students' initial hypothesis. 1 mark

c. With reference to the graph on page 25, justify whether the results of the experiment support the students' initial hypothesis. 2 marks

d. Explain the measures taken by Jamie and Sarah to ensure their experiment was repeatable. In your response, make clear the meaning of the term 'repeatability'. 3 marks

e. After the first set of tests, Jamie realised that they had not controlled the angle of the electric fan. As a result, the fan had shifted to a slightly different angle between each test.

i. Identify the type of scientific error that occurred. 1 mark

ii. Jamie claimed that the error would impact the accuracy of the experiment, while Sarah claimed that it would impact precision.

Explain which student is correct, making clear the meaning of the terms 'accuracy' and 'precision'. 3 marks

f. Describe **one** limitation of using this experiment to calculate the electricity generated by a real wind turbine. 2 marks

End of examination questions

