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

STUDENT NAME: _____ CLASS: _____

ENVIRONMENT EDUCATION VICTORIA

Victorian Certificate of Education 2022

Environmental Science

Trial Written Examination

Reading time: 15 minutes
Writing time: 2 hours

TEACHER VERSION – SUGGESTED SOLUTIONS IN RED

QUESTION AND ANSWER BO(

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	30	30	30
B	9	9	90
			Total 120

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

- Question and answer book of 26 pages
- Answer sheet for multiple-choice questions

Instructions

- Write your student number, name and class in the space provided above on this page.
- Write your student number, name and class in the space provided on your answer sheet for multiple-choice questions.
- Unless otherwise indicated, the diagrams in this book are not drawn to scale.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

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

Please note this is a practice exam only and its degree of hardship and content is different to the end of year exam.
EEV takes no responsibility for your success in completing the actual VCE Environmental Science exam.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1 ; an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.

Question 1

Ecosystems are sources of renewable services that impact humans. Pollination, water purification and control of climate are examples of

A. provisioning services
B. regulating services
C. cultural services
D. supporting services

Question 2

Silt barriers are often found along road construction and building sites to temporarily control sediment. This environmental engineering method can be used to decrease

A. chemical runoff
B. native animal road deaths
C. equipment loss
D. soil erosion

Question 3

Short term environmental changes such as fire and volcanic eruptions are most likely to threaten

A. species that are vulnerable, endemic or have a specialist niche
B. long term climate patterns
C. populations with a wide geographic range
D. highly resilient populations

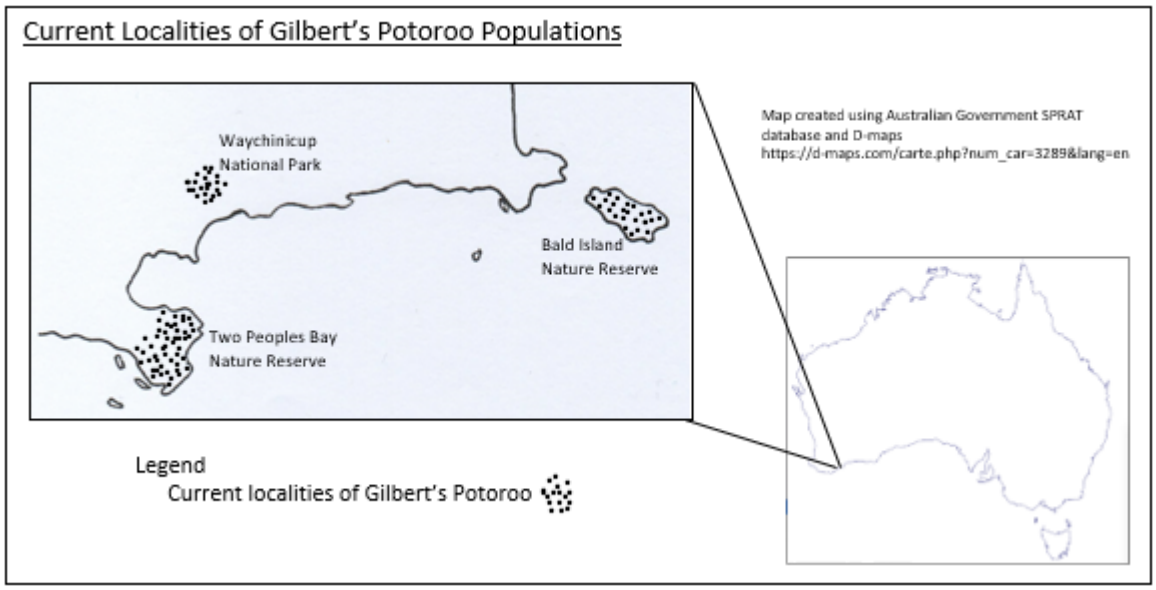
Question 4

Increasing concentrations of mercury along a marine food chain through different trophic levels is best described as

A. marine pollution
B. ecosystem services
C. biomagnification
D. bioaccumulation

Use the following information to answer Questions 5-8

The Gilbert's Potoroo is both Australia's most endangered marsupial and the rarest marsupial in the world. There are approximately 100-120 individuals. Gilbert's Potoroos are small with adults ranging in weight from 900g to 1200g. They are nocturnal, live in small groups or colonies, and are endemic to the south coast of Western Australia. Individuals are restricted to three isolated populations, one of which is an enclosed population at Waychinicup National Park.



Question 5

The Gilbert's Potoroo is classified as critically endangered by the International Union for Conservation of Nature (IUCN). This means that

A. it faces an extremely high risk of extinction in the wild in the immediate future.
B. it faces a very high risk of extinction in the wild in the near future.
C. is known only to survive in captivity.
D. it will qualify for a threatened category in the near future.

Question 6

A main threat to the Gilbert's Potoroo is low genetic diversity. Which strategy would be most suited to improving the genetic diversity of the potoroo?

A. Translocating all Potoroos into a captive facility away from predators.
B. Establishing a fourth fenced population using individuals from all three existing populations.
C. Taking individuals from the largest population and placing them into another suitable habitat.
D. Conducting controlled burns to minimise risk from fires and ensure the strongest Potoroos survive.

Question 7

The use of wildlife corridors linking the three existing populations has been suggested by scientists. A small number of tourism operators in south Western Australia are opposed to this plan as they believe it will reduce available land space for accommodation services. This value system viewpoint is an example of

A. ecocentrism
B. biocentrism
C. technocentrism
D. anthropocentrism

Question 8

Gilbert's potoroo is recognised as a threatened species under State and Commonwealth legislation. Which legal framework is used to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places in Australia?

A. International Union for Conservation of Nature (IUCN)
B. Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
C. *Flora and Fauna Guarantee Act 1988 (Vic)*
D. Convention on International Trade in Endangered Species (CITES)

Question 9

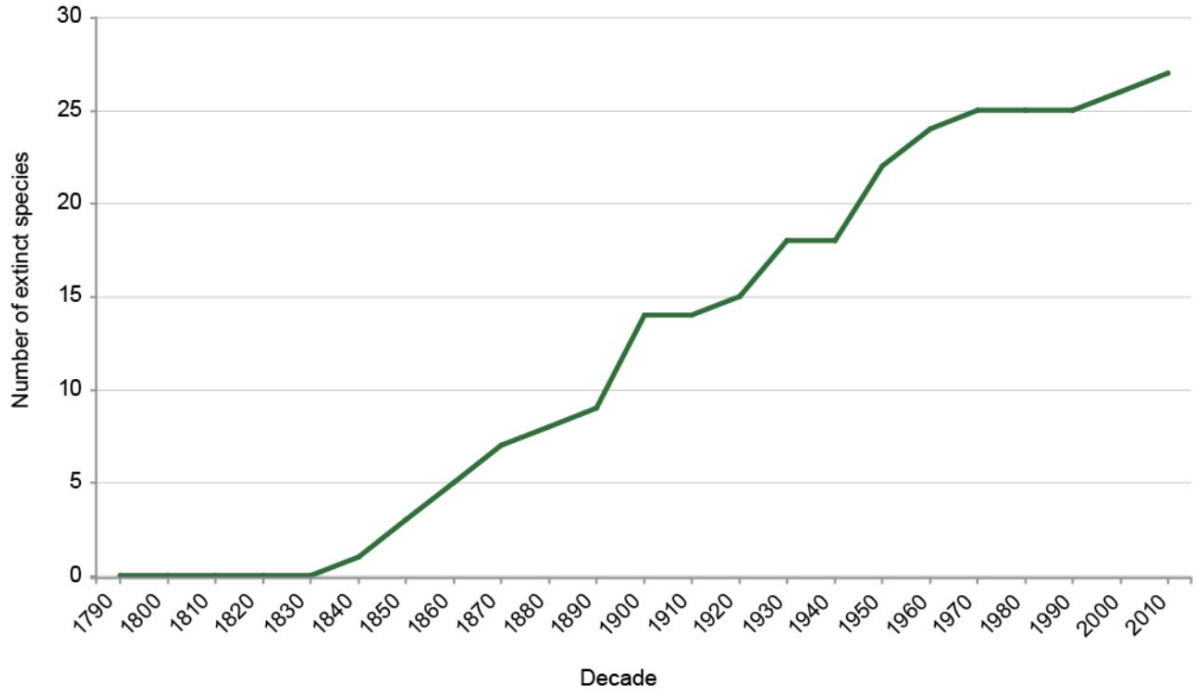


Image credit: Cresswell ID & Murphy HT (2017). Australia state of the environment 2016: biodiversity, independent report to the Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy, Canberra. CC BY-SA 4.0
https://soe.environment.gov.au/sites/default/files/soe2016-biodiversity-launch-version2-24feb17.pdf
Figure BIO19 pg. 68

The graph above shows the cumulative historical extinctions of Australian mammal species since European settlement.
Use the graph to determine the approximate percentage change in the number of extinct species between 1860 and 2010.

A. 44%
B. 81%
C. 440%
D. 181%

Question 10

A golf club is looking to move away from their current range of golf balls to a more sustainable type that can have its external covering reapplied. This would increase the lifespan of the ball. Once the ball is no longer able to be refurbished, it can be shredded and reused in the manufacturing of new balls. In this way, very few new resources need to be acquired in the production of the balls and very little waste is generated.

This system best represents

A. user pays principle.
B. circular economy thinking.
C. Earth systems thinking.
D. cost-benefit analysis.

Question 11

A proposed golf course borders on a parcel of swamp land. The Victorian Biodiversity Atlas indicates that the Southern Toadlet, a small and highly endangered frog species, has historic records at the swamp. Despite a lack of scientific evidence about the effect the development will have on the Southern Toadlet and its habitat, conservation groups have called on the golf course development group to put a vegetation buffer between the swamp and the new course.

This is an example of the use of

A. environmental risk analysis.
B. community consultation.
C. restorative practices.
D. precautionary principle.

Question 12

A development could be considered as ecologically sustainable if it

A. can be sustained in the long term without degrading the environment.
B. minimises the amount of pollution occurring during the construction phase.
C. meets all regulatory frameworks, including environmental standards.
D. does not cause the extinction of any species.

Question 13

Regulatory Frameworks attempt to

A. regulate development, so that local community consultation is not needed.
B. give local communities complete control over major projects in their region.
C. avoid the need for non-government organisations to be involved in decisions regarding development projects.
D. balance community needs against environmental damage.

Question 14

A higher amount of visible solar radiation enters the upper atmosphere compared to the amount reaching the surface of the earth. The difference between the two is due to

A. absorbance by greenhouse gases.
B. scattering in the upper atmosphere and reflection by clouds.
C. absorbance by the ozone layer.
D. the albedo effect.

Question 15

The global warming potential for greenhouse gases is calculated using

A. the amount of gas being produced by humans and its ability to absorb infrared radiation.
B. the amount of gas being produced by humans and its half-life in the atmosphere.
C. the length of time a gas persists in the atmosphere and its ability to absorb infrared radiation relative to carbon dioxide.
D. the amount of thermal energy an atmospheric gas can reradiate.

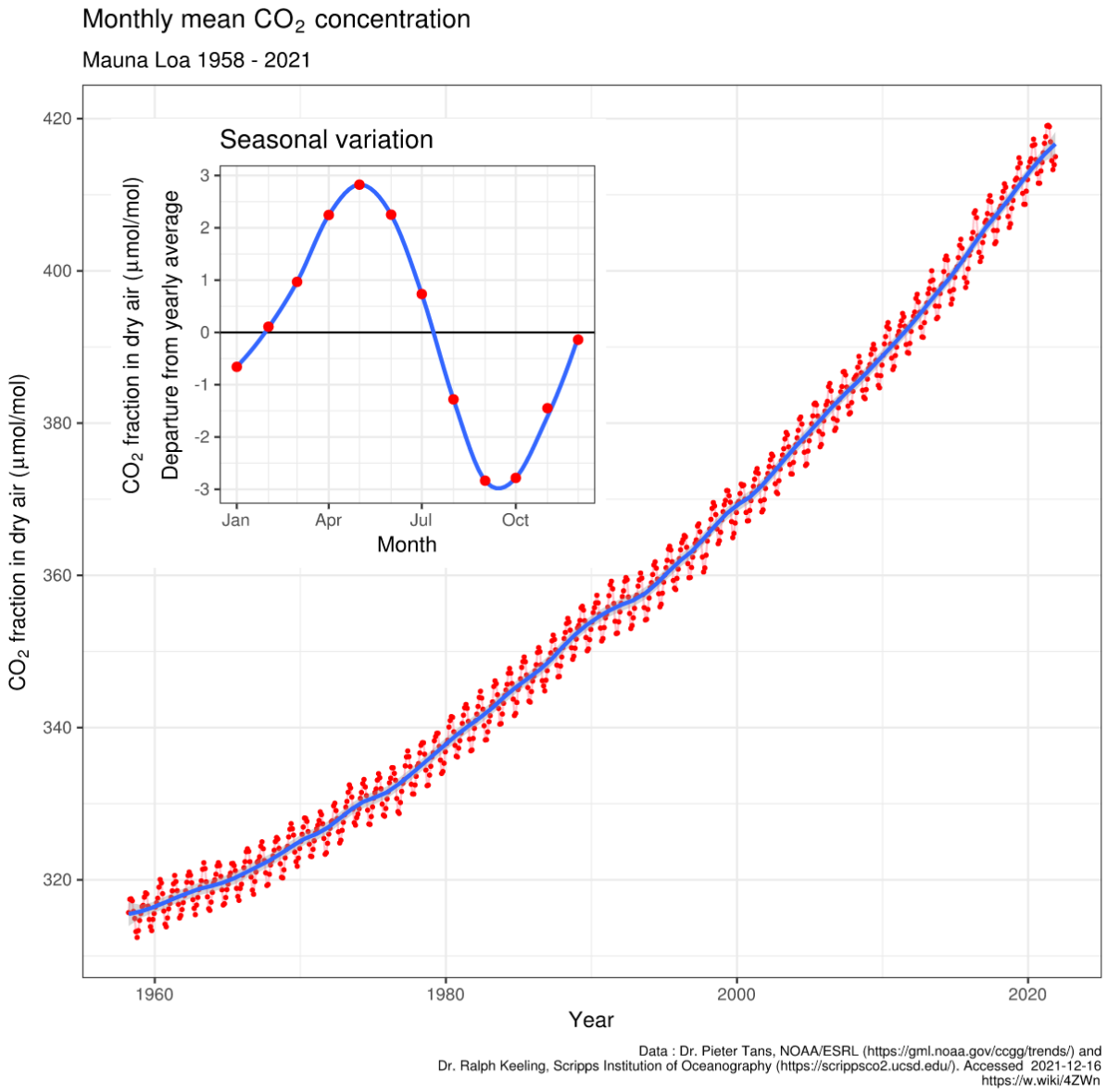
Question 16

A greenhouse gas can best be described as

A. a gas produced by human activities.
B. having an ability to absorb sunlight.
C. being transparent to visible wavelengths but not infrared.
D. a tropospheric gas that allows all wavelengths of solar radiation to pass through but reflects infrared radiation.

Use the following information to answer Questions 17&18

The graph below shows the carbon dioxide monthly mean concentration at Mauna Loa (Hawaii, USA)



Question 17

Direct measurements of CO_2 in the atmosphere since the 1960s have shown a seasonal cycle that occurs each year. The cause of this cycle is most likely

A. the cycling of industry between peak periods and holidays.
B. the influence of the northern hemisphere deciduous forests in storing and then releasing carbon dioxide.
C. due to large blooms of photosynthetic algae in tropical waters.
D. due to coal fired power plants running at higher outputs during the winter.

Question 18

The trend of carbon dioxide as shown in the graph can best be described as

A. random fluctuations.
B. seasonal with an upward trend.
C. cyclic with a downward trend.
D. seasonally cyclic.

Question 19
Past climatic conditions 200 to 300 years ago are best determined using

A. paleobotany.
B. ice core samples.
C. carbon dating.
D. fossils.

Question 20
The dominant contributor to sea level rise over the past 100 years is

A. thermal expansion of water.
B. melting of sea ice.
C. melting of land ice.
D. rivers carrying water into the sea.

Question 21
Ice core samples can be used to approximate temperatures with the use of

A. the concentration of methane trapped in bubbles of air.
B. dust and pollen grains trapped in the ice.
C. ratio of differing isotopes of oxygen in the frozen ice.
D. plant material trapped in the ice layers.

Question 22
When an open cut coal mine is closed the plan is to convert the mine void into a lake by filling it with water. It is estimated this would require at least 725 gigalitres of water and take approximately 20 years with normal river flows.
This type of rehabilitation project could be best described as mostly being

A. mechanical.
B. chemical.
C. biological.
D. environmental.

Question 23
An energy company plans to split its profitable renewable energy business from its non-profitable fossil fuel business. Environment groups are concerned that this would increase the risk of the new fossil fuel business eventually going bankrupt and therefore not be able to meet the costs of safely closing down the mines and gas plants, and restoring the environment as required. Instead, the cost of restoration will fall to governments and taxpayers.
The environment groups are concerned with which sustainability principle not being met by the company?

A. user pays principle
B. precautionary principle
C. efficiency of resource use
D. intragenerational equity

Question 24

Which of the following is always produced when combusting fossil fuels to generate electricity?

A. carbon dioxide
B. methane
C. nitrogen oxides
D. water

Question 25

Identify the non-renewable energy source in the following list

A. ethanol (a biofuel)
B. coal seam gas
C. solar thermal
D. geothermal

Question 26

Biomass as an energy source has the least negative impact on the environment when

A. crops are grown specifically for the production of energy.
B. biomass that currently goes to landfill is used.
C. plastic waste is burnt to produce energy rather than going to landfill.
D. fast growing plants are used in preference to slow growing plants.

Question 27

Poverty weed is an invasive plant that originated in North America. The plant grows to about 30cm high, and the top growth dies off in Autumn. A citizen science project in a rural town is looking for evidence of Poverty weed in their local bushland creek reserve.

Which of the following is the most appropriate method for the volunteers to determine the extent of infestation?

A. Conduct a walk through survey of the entire reserve to ensure no weeds are present.
B. Walk along either side of the creek bed as this is likely to be where most weeds will be found.
C. Select random areas and allocate these to groups of volunteers to monitor using quadrats.
D. Collect data to calculate Simpson's Index of Diversity to determine the impact of Poverty weed on the native flora.

Use the following information to answer Questions 28-30

Maria wanted to investigate the amount of energy per gram released by a burning candle when heating a can of water. She set up equipment as shown below. The mass of the candle before and after burning for 20 minutes and the increase in water temperature was recorded.

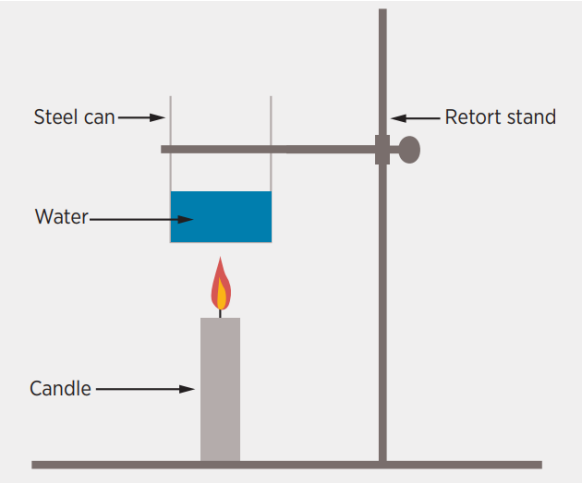


Image credit: Environment Education Victoria, Issues of Sustainability 5th ed, page 153.

Question 28

Which of the following would allow Maria to make her investigation more accurate?

A. Use a beaker to measure the volume of water.
B. Use a digital thermometer and data logging software.
C. Repeat the experiment three times and calculate the average change in temperature.
D. Weigh the candle afterwards with a different mass balance that had more decimal places.

Question 29

What should Maria do to improve her experiment so that she can compare different candles?

A. Make sure that the amount of water in the can is the same at the end of each experiment.
B. Ensure that the mass of the candles starts the same for each trial.
C. Use a can that has a lid with a small hole to allow the temperature to be measured.
D. Ensure the distance between the candle and the can is the same for different candles.

Question 30

Olympia used the same equipment as Maria but in addition to using a candle she used a spirit lamp with which she can burn small amounts of a liquid fuel.

Which of the following hypotheses could she test using this equipment?

A. Biofuels produce the same amount of carbon dioxide emissions per gram as fossil fuels.
B. Solid fuels produce less energy per gram than liquid fuels.
C. Liquid fuels are less effective than solid fuels.
D. Biodiesel has a lower boiling point than conventional diesel.

END OF SECTION A

SECTION B

Instructions for Section B

Answer all questions in the spaces provided.

Question 1 (17 marks)

Wilson's Promontory is Victoria's largest coastal wilderness area. It covers 50,000 hectares at the southernmost tip of mainland Australia.

Wilson's Promontory provides habitat for a wide variety of native wildlife including many threatened species.

A project developer has controversially been given permission to build an eco-village for tourists inside Wilson's Promontory National Park. This has drawn the attention of locals, government departments, environmental groups, and conservationists.

The eco-village will require permanent gravel roads to be created, along with the inclusion of services such as electricity and sewage. Temporary roads have been built to allow for construction machinery to enter the eco-village site. The location of the permanent gravel road system is yet to be determined. Two possible routes have been identified and they both contain threatened species. Ecotourism operators, residents from nearby towns, conservationists, and park rangers have approached the Minister for Planning to express their concerns about possible impacts on threatened species. Route 1 is directly through the park, whereas Route 2 runs parallel to a section of the coastline.

a. Briefly outline the precautionary principle and describe how it should be applied in this case.

2 marks

- Where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation (1).
- Therefore, as we are unsure of impacts on threatened species in Wilson's Promontory National Park, precautionary steps to ensure protection of the ecosystem should be taken in anticipation of that/those event/s (1).

Over one week, threatened flora and fauna species surveys were conducted using quadrats and traps along transects at both proposed road routes. Results are listed in Table1. The results from these surveys can be used to calculate the Simpson's Index of species diversity (D) to compare biodiversity of the road routes.

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

$$\text{Simpson's Index of species diversity:} \quad D = 1 - \frac{\sum [n_i (n_i - 1)]}{N(N-1)}$$

Note:

Σ	refers to the 'sum of'
n_i	represents the total number of organisms of each individual species
N	represents the total number of organisms of all species

A higher index value indicates higher species diversity.

b. Calculate Simpson's Index of species diversity (D) for Route 2 in the blank spaces in the table below. The index value for Route 1 has already been calculated.

3 marks

Table 1: Threatened species survey Wilson's Promontory National Park, Victoria, Australia.

	Route 1				**Route 2**		
Species	**n_i**	**$n_i - 1$**	**$n_i (n_i - 1)$**		**n_i**	**$n_i - 1$**	**$n_i (n_i - 1)$**
Plant 1	3	2	6		10	9	90
Plant 2	24	23	552		25	24	600
Plant 3	1	0	0		33	32	1056
Plant 4	5	4	20		12	11	132
Plant 5	2	1	2		9	8	72
Marsupial 1	1	0	0		1	0	0
Marsupial 2	1	0	0		6	5	30
Reptile 1	1	0	0		7	6	42
Bird of prey 1	2	0	0		2	1	2
Mammal 1	18	17	306		5	4	20
N =	58		$\sum[n_i (n_i - 1)]$ = 886	N =	110		$\sum[n_i (n_i - 1)]$ = 2044
N(N-1) =	3306			N(N-1) =	11990 (1)		
		D =	$1 - \frac{886}{3306}$			D =	$1 - \frac{2044}{11990}$ (1)
		D =	0.732			D =	0.8295 (1)

c. Compare the species richness of the two proposed road routes.

2 marks

- Species richness refers to the number of species for each route (1)
- Species richness is the same for both routes with 10 different species (1)

d. Compare the species diversity of the two proposed road routes.

2 marks

- A higher index indicates a higher level of diversity. Despite having the same species richness, Route 2 has greater species diversity (1)
- as it has an index of 0.8295 compared to Route 1 with an index of 0.732 (1).

e. Which of the two routes (1 or 2) would you recommend as the preferred for roads into the eco-village? Justify your recommendation using the data presented and calculated.

3 marks

- Route 2 should be used with protection measures in place, as it has a higher level of threatened species diversity compared to Route 1 (1)
- Route 1 should be the priority for protection as the abundance of threatened species is lower. For some species any reduction in individuals would result in complete loss of the species in that immediate area and loss of biodiversity (1)
- Students should use the abundance of species to justify their response. E.g. Marsupial 2 has 6 individuals for Route 2 but only 1 for Route 1, Reptile 1 (7 and 1), Plant 3 (33 and 1) (1)
  OR
- Students can select Route 1 with appropriate justification such as protection of home range for the species present, Route 2 possibly having more suitable habitat, limited data etc. To gain full marks the data must be used, however, simply stating that the Simpson's Index is higher for Route 2 and therefore it should be protected is not enough for full marks.

f. Suggest one additional factor that should be considered when planning the road development for the route you have chosen?

1 mark

Any reasonable response acceptable. For example
- Stakeholders
- Regulatory Frameworks
- Historical and current scientific data
- Cost-benefit analysis
- Risks/consequences/associated mitigation strategies

g. Some conservationists are concerned about how data was collected for this survey. Outline one way the method could be improved to determine a more accurate representation of biodiversity.

2 marks

Any reasonable response acceptable. 1 mark for stated option, 1 mark for explanation. For example
- Repetition to reduce statistical error
- Alternative methods for sampling mobile species such as mark-recapture
- Use of larger quadrats for plant species
- Sampling on multiple days over several breeding seasons

h. Developers of the eco-village have promoted their proposal to stakeholders as having a positive impact on the environment because tourists will develop a 'sense of place'. Define 'sense of place' and describe how this eco-village contributes to this ecosystem service.

2 marks

- Cultural services can provide a sense of place which refers to positive emotional bonds that people develop or experience in distinctive locations and environments (1).
- Positive impact of eco-village linked to this (1). Examples
  - By allowing tourists to stay within the National Park and experience nature, this can have positive impacts on other parts of their life such as physical and mental health and can link personal and environmental issues with positive outcomes.

- People are more likely to make positive behavioural changes if they have a connection to something. So the eco-village could encourage a connection that promotes eco-friendly behaviours and attitudes which will be taken back into other communities.

Question 2 (7 marks)
The New Holland Mouse is a very small endemic nocturnal rodent that historically had a continuous population along the east coast of Australia. It is listed as a threatened species due to its rapidly declining numbers since European settlement with ongoing threats such as habitat loss, altered fire regimes, foxes, root rot fungus, and coastal development.

It currently only exists in small, fragmented habitats across Tasmania, Victoria, NSW, and Queensland. Habitat for the New Holland Mouse is varied and can include coastal open heathlands, open woodlands, heathland understory, and vegetated sand dunes. The New Holland Mouse acts as a seed dispersal agent as it feeds predominantly on native seeds, leaves and fungi, and it provides ecosystem services such as soil and leaf litter turn over. It is also a vital source of prey for native predators.

a. The New Holland Mouse is endemic to the east coast of Australia. What does the term endemic refer to?

1 mark

- The New Holland Mouse is naturally found along the east coast of Australia and nowhere else (1)

b. List two possible strategies for improving the conservation status of the New Holland Mouse.

2 marks

Any reasonable response related to stem of question is acceptable. 1 mark for each strategy.
Examples
- Wildlife corridors / revegetation
- Feral proof fencing and feral animal reduction program
- Captive breeding and release
- Land for wildlife
- National Park creation

c. Describe one advantage and one disadvantage of each strategy you identified in question b.

4 marks

1 advantage + 1 disadvantage x 2 strategies = 4 marks
Examples
- ADV: Increases the size of habitat
- DISADV: Requires funding and time to develop

- ADV: Reduces incidences of predation from feral species
- DISADV: Requires significant funding and ongoing maintenance

- ADV: Increases population numbers in controlled environment and using multiple populations can ensure genetic diversity is maintained
- DISADV: If released into unprotected areas, the threats may still exist

- ADV: Habitat protected
- DISADV: Relies on private conservation and difficult to control feral animals on private property

- ADV: Habitat protected
- DISADV: Relies on government action and can involve long time frames

Question 3 (12 marks)

More than any other livestock industry, the Australian beef industry relies on healthy natural ecosystems. Over 63,000 farming businesses are producing beef from 43% of the country's landmass. They are also the world's second largest beef exporter, which injects an estimated $8.4 billion into the Australian economy. However, cattle production is costly to the environment. Clearing native vegetation for pasture has sacrificed wildlife habitat, and poor grazing practices have seen excess sediments enter waterways and damage places like the Great Barrier Reef. Cattle are also significant greenhouse gas producers, which contributes to climate change (wwf.org.au).

But it's not just the belching of greenhouse gases - livestock waste, particularly cow dung is a serious issue around the world. Recent research has estimated that by 2030, 5 billion tonnes of dung will be generated each year by livestock farms. (Estimation of global recoverable human and animal faecal biomass, David M Berendes et. al, Nature Sustainability Nov, 2018)

Cow waste not only causes nutrient problems in run off but is a breeding ground for flies. Australia has around 28.5 million cattle, each producing about 12 dung pads per day. One big cattle pad can produce 2000 to 3000 flies, resulting in billions of flies produced each year.

The introduction of European and South African dung beetles has led to the burial of much of the cow dung underground where it adds to the nutrient levels of the soil, increases pasture productivity and decreases fly numbers. However, these introductions are not without consequences, particularly on the more than 500 species of native dung beetles which they compete with, and on native vegetation communities which struggle to compete with introduced grasses on the more fertile soils.

a. Following a cost-benefit analysis, the Australian Government concludes that the introduction of invasive dung beetles is in Australia's interest overall. Focusing on economic, social, and environmental considerations explain how this might be regarded as sustainable development.

4 marks

- Explicit definition of sustainable development (1)- development that meets the needs of the current generation without compromising the needs of future generations.
- Economic argument (1) - worth $8.4 billion in trade, increased land productivity etc
- Social argument (1) - reduction in pest flies
- Environmental argument (1) - reducing GHG emissions through burial of waste, reduced waste runoff into waterways, negative effect on native species

b. Identify one role that each of the following stakeholder groups could play in the decision-making process regarding the importation of species like the dung beetle

2 marks

(accept first response only. Variety of answers possible – award full mark for any reasonable response)

- Government agencies
  - Risk assessment, regulatory frameworks,
- Cattle Farmers
  - Lobby government , inform stakeholders

c. Describe one impact the introduced dung beetle could have on the lithosphere and one impact it could have on the hydrosphere. In your response, make the definition for each sphere clear.

3 marks

- Clear definition of lithosphere (the outermost shell of the solid Earth - soil, landforms etc) and hydrosphere (all the water found on, in and above the Lithosphere - clouds, lakes groundwater) (1)
- Impact on lithosphere (1) – e.g. improve nutrient level of soil
- Impact on hydrosphere (1) – e.g. reduce nutrient runoff improving the quality of rivers and lakes

(the question asks for 1 impact of each - take the first answer only if student provides multiple impacts)

d. An alternative to the dung beetle is to use cattle dung in biogenerators to produce electricity. Explain how this can help address some of the fundamental challenges to sustainability. Be explicit in your answer as to what some of these fundamental challenges are.

3 marks

- Referencing at least two of population, food, water, or energy (2)
- Linking at least one of these to the question stem (1)
  - Examples
    While it does not address population it does
    - provide another energy source which helps to reduce the demand on traditional fossil energy sources
    - helps to maintain healthy waterways by preventing nutrient runoff which preserves drinkable fresh water systems
    - provide a level of food security by enabling livestock farms to continue to operate without the current level of waste.

Question 4 (6 marks)

There are more than 810,000km of roads in Australia. Many of the roads remain unsealed due to difficulties obtaining construction materials, high production costs and accessibility. The main components of sealed roads in Australia are bitumen (a crude oil product), crushed rock, compacted sand, and chalk.

Roads made from recycled and reclaimed materials are increasing around Australia. These road bases are more durable than traditional methods and are made from a variety of materials such as crushed concrete, recycled asphalt, recycled hard and soft plastics, printer waste toner and cartridges, glass, old tyres, reclaimed asphalt pavers and vegetable oils.

a. Explain how the sustainability principle, intergenerational equity applies to this scenario. Make the meaning of the term 'intergenerational equity' clear in your response.

3 marks

- Intergenerational equity refers to fairness between present and future generations. It means current generations inherit the Earth from previous generations and have an obligation to pass it on in reasonable condition to future generations (1)
- By using recycled and reclaimed materials for road construction it means that resources will still be available for future generations (1) and the longer durability of the roads will mean upgrades are less frequent (1)
- Or any reasonable, directly related explanation

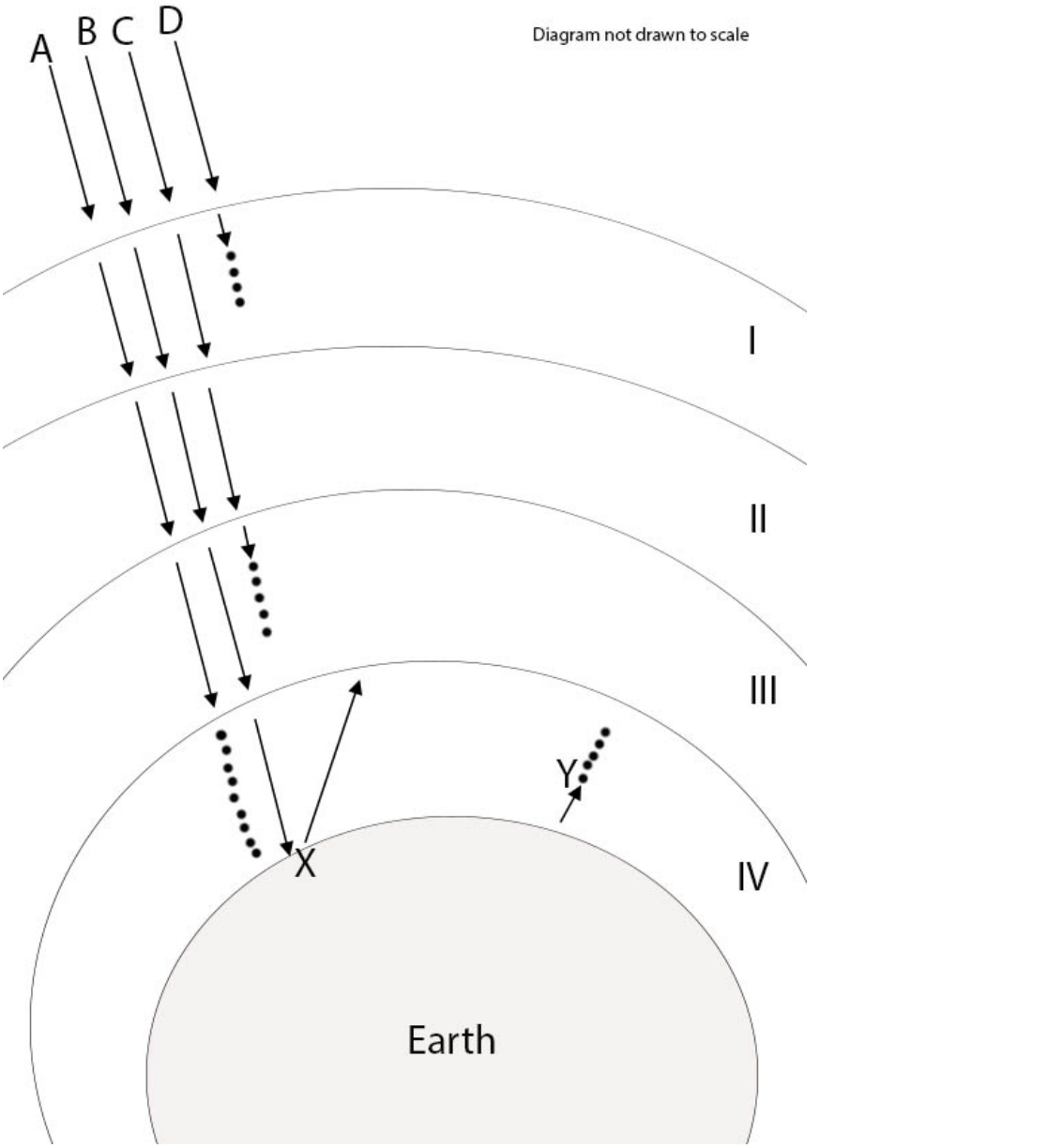
b. Explain how the use of recycled and reclaimed materials for road construction in Australia represents circular economy thinking. Make the meaning of the term 'circular economy' clear in your response.

3 marks

- A circular economy aims to reduce environmental impacts of production, improve the sustainability of natural resource use, and enable economic growth (1)
- This type of thinking is represented by the design and construction of roads that reuses and avoids waste and limits the impact on the environment as fewer natural resources need to be sourced (1)
- These roads will improve the economy and social inclusion between local and state communities (1)
- Or any reasonable, directly related explanation

Question 5 (10 marks)

The diagram below shows Earth, solar radiation (labelled A - D) and layers of Earth's atmosphere (labelled I – IV)



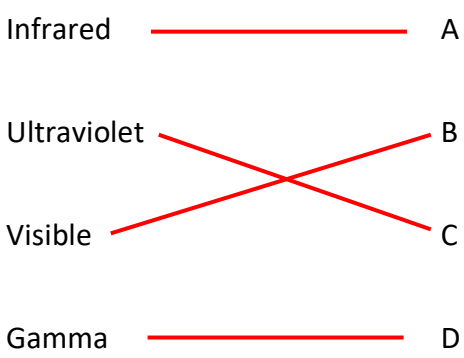
a. Which layer of the atmosphere (I, II, III or IV) is the troposphere?

1 mark

– IV

b. Draw a line to correctly match the solar radiation type

4 marks



c. Name and explain the process occurring at point X on the diagram.

2 marks

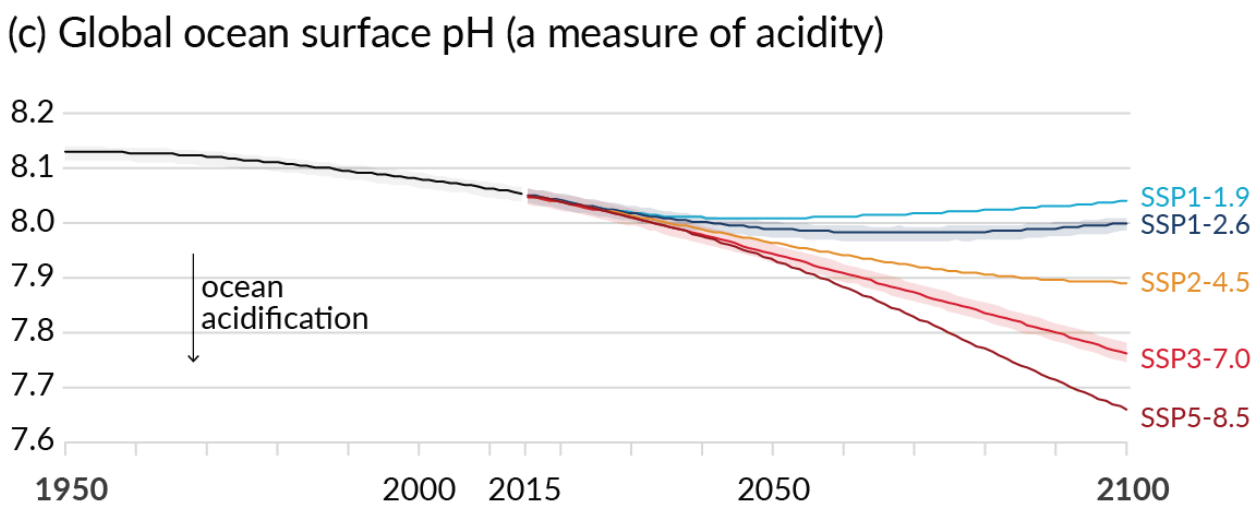
- Albedo effect (1)
- Visible light is reflected (do not accept reradiated) from light surfaces such as ice (1)

d. Name and explain the process occurring at point Y on the diagram

3 marks

- Greenhouse effect (1)
- Greenhouse gases absorb outgoing Infrared radiation (1)
- Greenhouse gases gain kinetic energy warming the lower atmosphere (1)

Question 6 (8 marks)



Source: Figure SPM.8 in IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY,USA, pp. 3–32, doi:10.1017/9781009157896.001 https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

a. SSP1 to 5 in the graph above relate to differing future scenarios as published in the IPCC's 6th assessment report. Suggest two possible variables that forecasters might need to take into consideration when generating climate models and projections.

2 marks

- Multiple possible answers – full marks for any two reasonable answers.
- The question doesn't restrict answers to variables that just effect ocean acidification. Clearly GHG emissions will be a common answer but also revegetation generating sinks or even aerosol emissions, human population growth etc.

b. Explain the current cause of ocean acidification and some of the consequences

3 marks

- Do not accept increased CO_2 levels alone – the question asks for an explanation
- The increased levels of CO_2 in the atmosphere are being taken up by the oceans and forming carbonic acid (acceptable to suggest increasing CO_2 levels in the atmosphere react with water to form an acid or CO_2 dissolved in water is converted into an acid) (1)
- More than one reasonable consequence – at least one needs to explain the connection to acidification. For example, increased acidity makes it more difficult for marine species to form carbonate shells, etc. (2)

c. There are over 100 major climate models in use worldwide, all intend to make predictions about future climates. Some of these climate models produce predictions that are more accurate than other models.

i. Identify one possible attribute of the models that might differentiate the accuracy.

1 mark

One reasonable response (1)
Examples
- Higher resolution data collection (or grid size) allows more data to be assessed improving the model's accuracy

- The more systems the climate models take into account the more accurate the outcome
- The larger the computer system the more simulations a model can run

ii. All climate model predictions become less accurate the further into the future they predict. Suggest one reason why this might be the case

1 mark

- It becomes increasingly more difficult to predict the baseline data the models rely on such as GHG emissions , world population, socioeconomic status of populations, level of deforestation etc.

iii. Describe one way scientists can validate the accuracy of their climate models.

1 mark

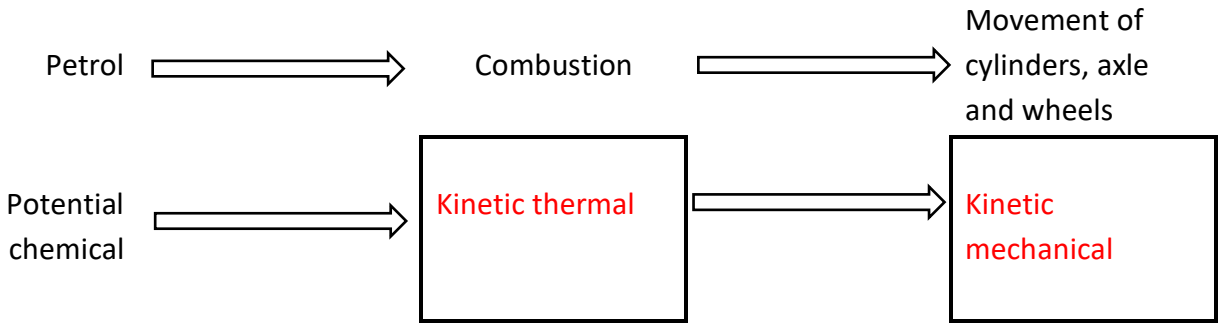
- Hind-casting (using the model to predict past climate and compare to records)

Question 7 (10 marks)

Electric vehicles contribute to building a sustainable energy future that produces lower greenhouse gas emissions. A plug in hybrid electric vehicle (PHEV) has an internal combustion (IC) engine and a battery powered electric motor. Unlike the more common hybrid electric cars the electric motor is the main motor with the IC engine as backup, and while in some cars the IC engine can be used to charge the batteries you generally have to plug the car in to recharge the battery.

a. Complete the below diagram showing the energy conversions that occur when the petrol fuelled IC engine is driving the car.

2 marks



b. 1 L of petrol has approximately 31MJ (1MJ = 1,000,000J) of energy contained within it and scientists have calculated that about 9MJ is transferred into the kinetic energy that drives the car. Calculate the energy efficiency of the IC engine based on these figures. Show your workings.

2 marks

(9/31) x 100 = 29%

(1) workings

(1) correct answer (including %)

c. One feature of electric vehicles that improves efficiency is something called regenerative braking. When the driver removes their foot from the accelerator essentially some of the kinetic energy is converted back into electrical energy by driving the motor backwards and recharging the battery. What is the likely impact of this technology on the level of greenhouse gas emissions from a PHEV?

1 mark

– Emissions would be lower (1)

d. A member of an electric vehicle enthusiast web site claimed they drove their fully electric vehicle very carefully in a hilly area and that the regenerative braking meant that the energy used to drive up a hill was fully recovered, and the car has not needed charging for over three months. Explain using your understanding of the laws of thermodynamics why this claim is unlikely to be true

3 marks

- First law of thermodynamics states that energy is neither created nor destroyed but is converted from one form to another (1)
- Second law of thermodynamics states that when energy is converted from one form to another, some of it becomes degraded to lower quality energy (1)
- Therefore, you can't get more energy out than you put in and no energy conversion is 100% efficient. Even if some energy is recovered by the braking system some energy is dispersed in the conversion process and therefore can't keep the battery charged to the extent claimed (1)

e. Many electric vehicle owners have smart chargers installed in their homes. These have the ability to control when the vehicle is charged to avoid times when electricity demand is high. Some newer models of electric vehicles and charger systems are also able to feed electricity back to the grid or to the house in the event of a power cut. Explain how this new technology fits with the efficiency of resource use sustainability principle.

2 marks

- Because the cars can feed back into the grid they act like a battery (1)
- This means you don't have to build more power generation and therefore reduces resource use (1)

Question 8 (6 marks)

Much of the natural gas used by the southern states of Australia is produced by offshore gas and oil fields in Bass Strait between Victoria and Tasmania. Recent projections from the Australian Energy Market Operator suggest that in the near future there will not be enough natural gas to meet daily demand in Victoria across the entire year.

a. At what time of the year is peak demand for natural gas likely to occur in Victoria?

1mark

- Winter (due to heating)

b. While demand is expected to increase in line with population, the projected reduction in supply from the offshore gas fields is part of a wider trend seen in both oil and gas resources. Name this phenomenon and describe how it explains the projected decline in supply from the offshore gas fields in Bass Strait and fossil fuels in general.

2 marks

- Peak Gas/Oil (1)
- Production is low and increases until it reaches a peak at which point it declines as the reservoir is depleted due to being extracted at levels well above replenishment (1)

c. Describe one action an individual or business could implement to reduce the demand for natural gas and something the state government could do that would support the individual or business action.

3 marks

- One individual or business action directly linked to natural gas use (accept first response only) (2)
  Examples
  - Swap natural gas appliances (stove/heating) for electrical ones
  - Replace inefficient gas appliances with efficient ones
  - Improve building insulation to reduce demand for gas heating
  - Install water efficient appliances to reduce requirements for gas heated hot water

- Government action directly linked to individual action (1)
  Examples
  - Government subsidies/rebates for such work
  - Increased spending on training of electrical installers

Question 9 (14 marks)

Using a small electric motor attached to a hub that can hold plastic blades, a group of students carried out an investigation to determine if the number of blades influenced the voltage that a wind turbine produces.

They attached the motor and hub onto a retort stand and placed it onto a table, as shown in the diagram on the right. The air from an electric fan was directed onto the two-blade turbine. The voltage, in volts, measured by a multimeter was recorded. The students repeated the experiment adding more blades for each trial.

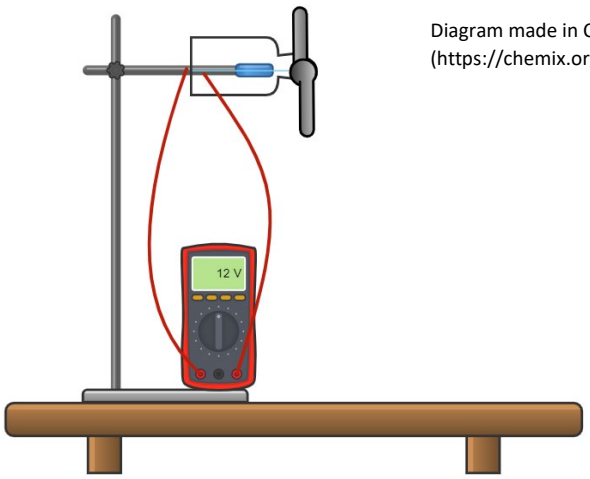


Diagram made in Chemix (https://chemix.org)

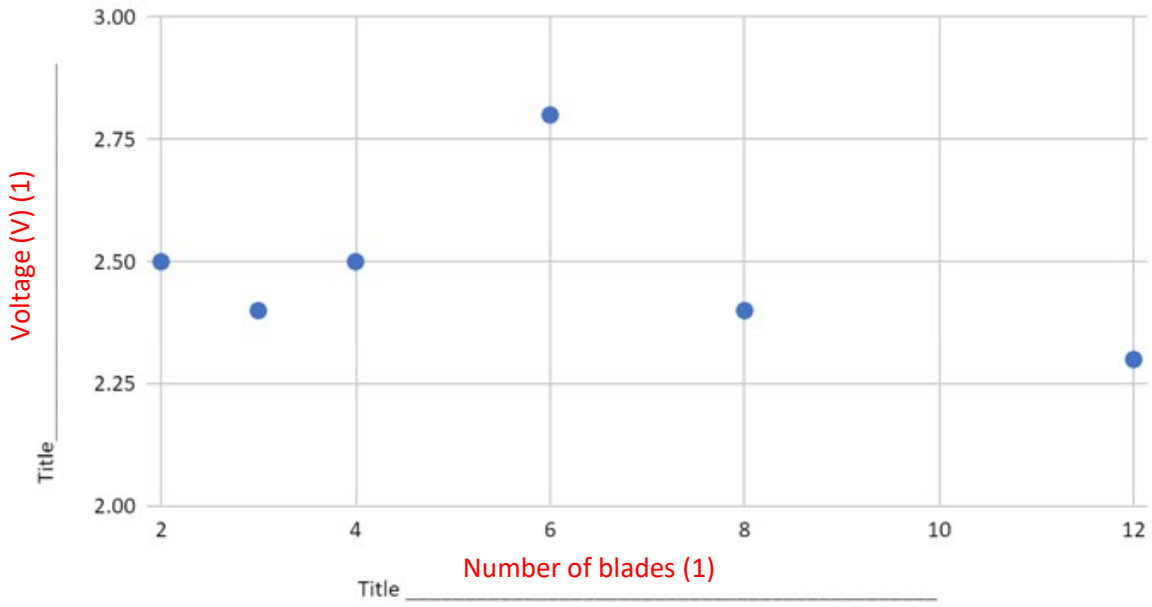
a. Identify the Independent Variable in this investigation.

1 mark

Number of blades

b. The results from the investigation are shown in the graph below. Label the graph axes.

2 marks



Data: Adapted from STELR Wind Energy module
https://stelr.org.au/stelr-modules/wind-energy/

c. As they had observed that commercial turbines typically have three blades, the students hypothesised that three blades would produce the highest voltage and be the optimum number of blades.
Was their hypothesis supported or not supported? Use the data from the graph to justify your claim.

2 marks

- Not supported (1)
- Highest voltage (2.8V) was achieved for 6 blades compared to 2.4 V for 3 blades (1)

d. One of the students claimed that the number of blades has very little impact on the voltage produced and that the graph is misleading.
Identify one feature of the graph that could have led them to this conclusion.

2 marks

- The scale on the Y axis shows only the data between 2 and 3 V and therefore exaggerates the differences (1)
- The actual values are very close together 2.3-2.8V thus it is reasonable to say there is little difference (1)

e. Identify one systematic error that could have occurred during this investigation.

1 mark

- Faulty multimeter

f. The students didn't note down the type of fan, its speed setting or distance from the turbine. Explain how these omissions would affect the repeatability of the experiment.

2 marks

- To repeat the experiment it needs to be carried out under the same conditions of measurement (1)
- The missing information makes it difficult to repeat the experiment as these variables are likely to affect the voltages that are produced therefore results are likely to be different (1)

g. The students noted there was no sound from the turbine. Based on this they concluded that the wind turbine didn't produce any infrasound (sound below the range of human hearing) and therefore claims by people that they suffer from poor health, sleeplessness and psychological harm caused by the low frequency sounds coming from wind turbines are false.
Explain how valid their conclusion is, given the information from the experiment.

2 marks

- Not valid as they did not measure sound below the range of human hearing (1)
- Therefore, as they do not have data to support the claim, they cannot claim the turbines do not produce infrasound and that there are no health consequences from such exposure (1)

h. Engineers have been focussed on reducing the noise produced by wind turbines partly in response to stakeholder concerns about noise levels but predominantly for reasons of energy efficiency. Explain why a noisy turbine is an inefficient one.

2 marks

- Sound energy is not a desired energy transformation (1)
- The more sound energy the less efficient the conversion of kinetic energy to electrical energy (1)

END OF QUESTION AND ANSWER BOOK