

Victorian Certificate of Education  
Year

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER								Letter

## ENVIRONMENTAL SCIENCE

## Written examination

## Day Date

Reading time: \*.\* to \*.\* (15 minutes)

Writing time: \*.\* to \*.\* (2 hours)

## QUESTION AND ANSWER BOOK

## Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
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 38 pages
- Answer sheet for multiple-choice questions

**Instructions**

- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- 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.**

**SECTION A – Multiple-choice questions****Instructions for Section A**

Answer **all** questions in pencil 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**

Which one of the following is the best definition of species diversity?

- A. the total number of genetic characteristics in the genetic make-up of a species
- B. the variety of different genetic material, species and ecosystems in the biosphere
- C. the variation found in a region or the variation in ecosystems across the whole planet
- D. a measure of the diversity within an ecological community, which incorporates both species richness and the evenness of species abundance

**Question 2**

Koala populations throughout Australia have a low genetic diversity. In particular, Victorian koalas have a much lower genetic diversity than Queensland koalas.

As a result of low genetic diversity

- A. Queensland koalas would not be able to interbreed with Victorian koalas.
- B. the koala species will be more able to survive habitat changes due to global warming.
- C. the Queensland koala population is likely to face more problems due to inbreeding than the Victorian koala population.
- D. the Victorian koala population will be less likely to be able to withstand environmental selection processes than the Queensland koala population.

**Question 3**

The rosy periwinkle (*Catharantus roseus*) is a small plant that is endemic to rainforests on the island of Madagascar. In the 1950s, scientists discovered that the plant contained chemical compounds called alkaloids. These compounds have become important drugs used in chemotherapy treatment for cancer. This is an example of an ecosystem providing a source of renewable services that has a positive effect on human wellbeing.

This example would be best classified as a

- A. regulating service.
- B. population service.
- C. supporting service.
- D. provisioning service.

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**Question 4**

Scientists currently believe that the largest mass extinction event on Earth occurred around 250 million years ago, when up to 95% of all species became extinct.

Evidence of this extinction has been collected from

- A. studies of the variety and range of many different dinosaur fossils.
- B. comparisons between current-day biodiversity and the range of species identified in the fossil record.
- C. a range of scientific sampling methods, including quadrats and transects, carried out correctly and accurately.
- D. investigations into the fossil record, data related to previous sea level and atmospheric changes as well as geological records of past asteroid impacts.

**Question 5**

Under the *Environment Protection and Biodiversity Conservation Act 1999*, the Australian Government has listed the dumb gulper shark as ‘conservation dependent’.

This means that the species

- A. only exists in captive breeding populations in large aquariums.
- B. is well protected in the wild by various conservation measures that are managed by the government.
- C. is dependent on specific species or habitat protection programs to prevent it from becoming threatened with extinction.
- D. is likely to become extinct in the near future if conservation measures continue to be carried out under the framework of the Act.

**Question 6**

After the last specimen of Leadbeater’s possum (first identified in 1867) had been collected in 1909, the species was believed to have been extinct in its known habitat in south-west Gippsland. It was not rediscovered in Gippsland, but near Marysville in the Central Highlands of Victoria in 1961.

What does this rediscovery mean?

- A. The population near Marysville should be classified as a different species.
- B. The geographic range of the Leadbeater’s possum’s habitat had been extended.
- C. The conservation category of Leadbeater’s possum changed from critically endangered to threatened.
- D. The population near Marysville was under threat from being genetically swamped by the Gippsland population.

**Question 7**

A group of scientists uses nets to catch eel-tailed catfish in a lake in order to collect data using the mark-recapture method. They capture, mark and release 15 catfish the first time that they net the lake. The second time that they net the lake, they capture 25 catfish, of which five had been marked.

Using the mark-recapture method, what is the estimated population of catfish in the lake?

- A. 30
- B. 45
- C. 75
- D. 125

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**Question 8**

The islands of New Caledonia have varied landforms, a range of microclimates and some unusual soil conditions. Some of the islands developed from the supercontinent Gondwana and separated from Australia around 66 million years ago. Other islands formed as a result of volcanic activity and coral reef development. The islands of New Caledonia have been relatively isolated in their present position for around 50 million years.

As a result, New Caledonia has

- A. fewer species due to its isolation in the Pacific Ocean.
- B. a wide biodiversity of endemic plant and animal species.
- C. a similar range of species to Australia because it used to be joined to the continent.
- D. a similar range of species to other tropical island groups throughout the Pacific Ocean.

*Use the following information to answer Questions 9–13.*

A particular native Australian bird species is critically endangered. The endemic bird population has a limited range in Western Australia. A two-hectare region just outside of the current range is being revegetated with the aim of providing more suitable habitat for the bird species. A quadrat study will be set up within the region to observe the quantity and quality of the vegetation before and after revegetation.

Until recently, simple spotting had been used to monitor the bird population. However, a mark-recapture method is now being implemented to monitor population numbers over time.

**Question 9**

Based on the information provided, what is a key threat to the survival of the bird species?

- A. bioaccumulation
- B. over-exploitation
- C. loss of pollinators
- D. habitat modification

**Question 10**

The revegetation and monitoring strategies for the bird species are most likely to be developed and described under the guidelines of the

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

**Question 11**

One advantage of the mark-recapture method, compared to a simple spotting technique, is that the mark-recapture method

- A. uses fewer physical resources than spotting.
- B. requires fewer qualified personnel than spotting.
- C. is more likely to result in the same bird being counted twice.
- D. produces results that are less likely to be influenced by experimental error or bias.

**Question 12**

What is the primary purpose of recording the amount and type of vegetation before revegetation?

- A. to monitor population numbers of the bird
- B. to ensure that no weeds are present in the quadrat
- C. to provide a standard of comparison to determine the success of the strategy
- D. to determine if any endangered species are present and their relative abundance

**Question 13**

Native plant specimens that were extracted from a seed bank were sown to provide species diversity in the revegetated region.

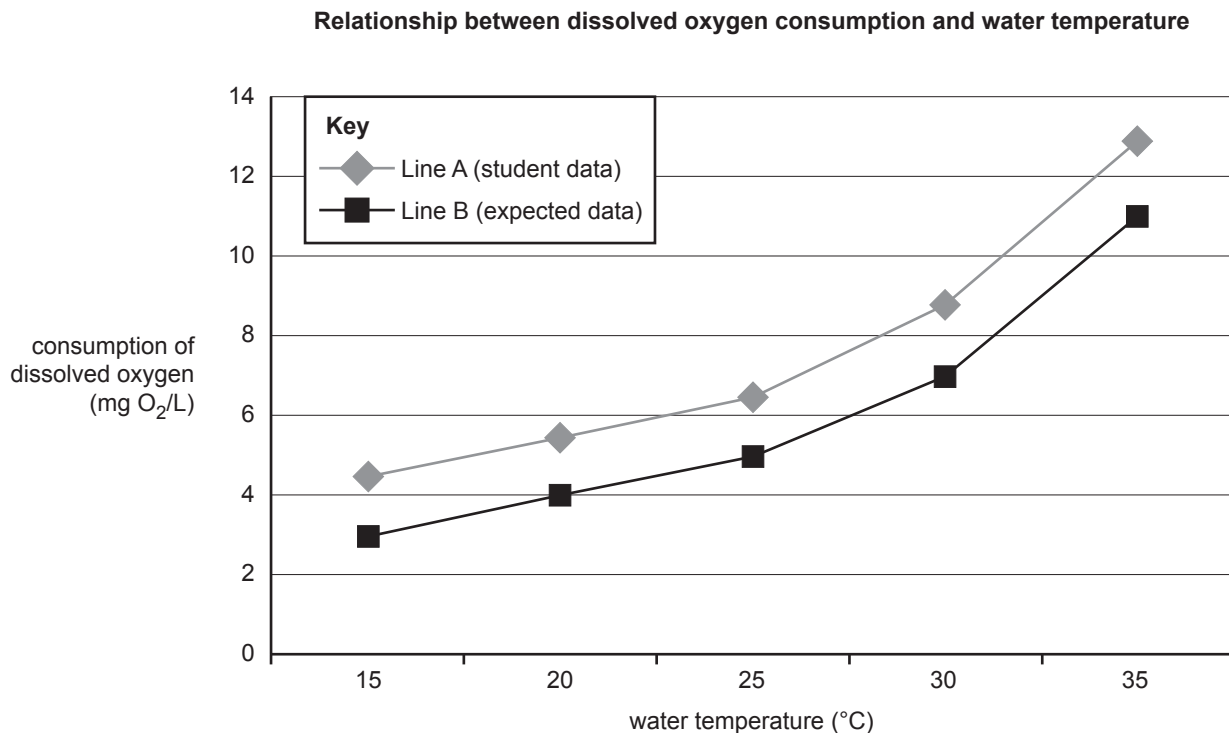
A seed bank is an example of

- A. a studbook.
- B. a gene bank.
- C. captive breeding.
- D. remnant vegetation.

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**Question 14**

A dissolved oxygen probe that includes a thermometer was used by students conducting water sampling in a small pond. The results they obtained are shown as Line A on the graph below. The consumption of dissolved oxygen is due to an increase in the respiration rate by aquatic organisms as water warms. Line B shows the expected consumption of dissolved oxygen as temperature increases. It is based on the collected data from many previous scientific measurements of this pond under the same conditions.



Data: Line B data derived from J Kepenyes and L Váradi, 'Aeration and Oxygenation in Aquaculture', in *Inland Aquaculture Engineering*, FAO, Chapter 21, 1984

The results obtained by the students are most likely due to

- A. a random error.
- B. experimental bias.
- C. a systematic error.
- D. an inaccurate calculation.

**Question 15**

Fossil fuels

- A. are found only in liquid form.
- B. were first used by people in the 1900s.
- C. were all formed in the past one million years.
- D. were formed from prehistoric plants and animals.

**Question 16**

What does the term ‘peak oil’ refer to?

- A. the best-quality oil for transport
- B. the highest price for a barrel of oil
- C. the time when maximum oil use occurs
- D. the time when the maximum rate of extraction of petroleum is reached

**Question 17**

Which of the following includes only renewable sources of energy?

- A. biomass, solar, tidal
- B. wood, steam, nuclear
- C. wind, tidal, coal seam gas
- D. natural gas, hydro-electric, geothermal

**Question 18**

The first law of thermodynamics states that

- A. mass can be transformed into energy.
- B. energy is neither created nor destroyed.
- C. energy cannot be transformed from one type to another.
- D. when energy is transferred or transformed, more and more of it is wasted.

**Question 19**

The albedo effect refers to the

- A. fraction of solar energy reflected from Earth back into space.
- B. amount of ultraviolet, visible and infra-red radiation emitted by the sun.
- C. effect of incoming solar energy on ice sheets, snow levels and polar ice caps.
- D. absorption of visible light by Earth’s surface, which is then re-radiated as infra-red radiation.

DO NOT WRITE IN THIS AREA

Use the following information to answer Questions 20–22.

The Intergovernmental Panel on Climate Change (IPCC) regularly reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide that is relevant to the understanding of climate change. The IPCC publishes reports based on this information, including the latest scientific estimates of the global warming potential of greenhouse gases. Greenhouse gases with a high global warming potential tend to have a large infra-red absorption and a long atmospheric lifetime.

**Global warming potential of selected greenhouse gases relative to carbon dioxide  
(based on a 100-year time horizon)**

Greenhouse gas	Global warming potential	
	Second Assessment Report (1995)	Fourth Assessment Report (2007)
carbon dioxide	1	1
methane	21	25
nitrous oxide	310	298
chlorofluorocarbon-11	3800	4750
chlorofluorocarbon-113	4800	6130
hydrofluorocarbon-23	11 700	14 800
sulfur hexafluoride	23 900	22 800

Data: IPCC, *Climate Change 2007: Synthesis Report, Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, IPCC, Geneva (Switzerland), 2007, 104 pp; core writing team: RK Pachauri and A Reisinger (eds)

**Question 20**

What does the data in the table suggest?

- A. Methane has a similar global warming potential to nitrous oxide.
- B. Sulfur hexafluoride has a lower global warming potential than carbon dioxide.
- C. Hydrofluorocarbon-23 has a global warming potential 14 800 times greater than carbon dioxide, as estimated in 2007.
- D. Chlorofluorocarbon-113 has a greater global warming potential than carbon dioxide, but not as great as that of chlorofluorocarbon-11.

**Question 21**

The data in the table suggests that scientific evidence has been re-evaluated between 1995 and 2007, and that the IPCC found that

- A. less chlorofluorocarbon-113 was produced over this 12-year period.
- B. the global warming potential of chlorofluorocarbon-11 was underestimated in 1995.
- C. nitrous oxide has little impact on global warming and its effect is actually decreasing.
- D. a larger amount of hydrofluorocarbon-23 was being released but less sulfur hexafluoride was emitted over this time period.

DO NOT WRITE IN THIS AREA



**Question 22**

Global warming scientists have focused their efforts on managing the enhanced greenhouse effect by trying to reduce atmospheric carbon dioxide levels because

- A. of the extremely large amounts of carbon dioxide being emitted as a result of human activities.
- B. scientists have already controlled the use of gases such as chlorofluorocarbons by having their use in aerosol cans banned.
- C. carbon dioxide has a larger infra-red absorption but a shorter atmospheric lifetime than the other greenhouse gases listed in the table.
- D. atmospheric carbon dioxide levels can be more easily controlled through the use of geosequestration, carbon sinks and non-fossil fuels.

**Question 23**

Coral reefs are complex ecosystems that are facing a number of threatening processes on a global scale. One such threat is increasing ocean acidification due to the increase in the amount of carbon dioxide being absorbed from the atmosphere. Another threat is coral bleaching due to an increase in ocean temperatures.

Both of these impacts

- A. are caused by the natural greenhouse effect.
- B. will eventually result in coral reef ecosystems becoming extinct.
- C. are of little concern due to the high levels of biodiversity in coral reef ecosystems.
- D. are caused by the increasing levels of carbon dioxide that have been added to the atmosphere by human activities.

DO NOT WRITE IN THIS AREA

Use the following information to answer Questions 24 and 25.

Ava conducts an experiment to investigate the heat absorption of carbon dioxide gas. She uses a light globe to supply infra-red radiation to a 1 L glass container to which different concentrations of carbon dioxide are added. After 10 minutes, she measures the temperature in the container. She repeats the experiment two times. Ava then changes the concentration of carbon dioxide and repeats the process.

Her results are presented in the table below.

Experiment number	Concentration of carbon dioxide (parts per million)	Final temperature (°C)
1.1	200	20.1
1.2	200	20.0
1.3	200	20.1
2.1	300	22.3
2.2	300	22.1
2.3	300	22.4
3.1	400	23.8
3.2	400	23.7
3.3	400	23.7
4.1	500	25.1
4.2	500	24.8
4.3	500	24.9

#### Question 24

Ava analysed the results of the experiment and correctly arrived at the conclusion that

- A. increasing the concentration of carbon dioxide increases the amount of heat absorbed.
- B. the measurements that she recorded were too inconsistent to reach an accurate conclusion.
- C. varying the concentration of carbon dioxide had no direct effect on the temperature in the container.
- D. the temperature increased initially but declined when a certain concentration of carbon dioxide was reached.

#### Question 25

What was the main reason for Ava repeating each experiment three times?

- A. to eliminate error
- B. to include a control
- C. to increase the number of variables
- D. to reduce experimental uncertainty

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**SECTION A – continued  
TURN OVER**

*Use the following information to answer Questions 26–30.*

Ragwort is a noxious weed. It is a major problem in Victoria's Strzelecki, Otway and Dandenong ranges. More than 1000 dairy farms are affected by the weed.

Biological control involves introducing a living predator (plant or animal) to control the species rather than using a chemical pesticide. Researchers are examining the use of beetles and moths as a biological control for ragwort. The beetles and moths will feed on the weed. This is an alternative to using chemical pesticides to kill the ragwort.

**Question 26**

For biological control to contribute to ecologically sustainable development, it is essential that

- A. pesticide companies maintain profits.
- B. food production is high in all regions.
- C. there is community support for biological control.
- D. biological control does not degrade the environment for future generations.

**Question 27**

Which of Earth's systems is the focus of the research?

- A. biosphere
- B. lithosphere
- C. atmosphere
- D. hydrosphere

**Question 28**

It has been argued that there are four key challenges to sustainability.

Which of these four challenges are the researchers trying to tackle?

- A. food
- B. water
- C. energy
- D. population

**Question 29**

The researchers are using historical and current data comparisons as measures of the effectiveness of the biological control of ragwort.

Which variable should be monitored?

- A. ragwort numbers
- B. use of chemical pesticides
- C. the number of dairy farms
- D. the number of study sites in the Otway and Dandenong ranges

**Question 30**

In order to develop an understanding of the potential impacts of releasing different species of beetles and moths into the Victorian environment, the researchers should undertake further investigation.

Which one of the following methods would be the most appropriate type of investigation to do this?

- A. a bioaccumulation study of the chemical pesticides currently being used
- B. a risk management assessment of these insect species in different ecosystems
- C. consultation with local communities, environmental interest groups and relevant government agencies
- D. a data comparison that measures and compares the effectiveness of these insect species in controlling ragwort

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**END OF SECTION A  
TURN OVER**

## SECTION B

## Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.

## Question 1 (7 marks)

An ecological survey of a heathland habitat in eastern Victoria (Site A) was conducted by a group of scientists studying small, ground-dwelling mammals.

Simpson's Index of species diversity ( $D$ ) was used by the scientists to quantify the mammal diversity of the habitat. Simpson's Index can be calculated as follows.

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

Note:  $\sum$  refers to the 'sum of'

$n_i$  refers to the total number of organisms of each individual species

$N$  refers to the total number of organisms of all species

A higher index value indicates greater species diversity.

Mammal species (at Site A)	$n_i$	$n_i - 1$	$n_i(n_i - 1)$
long-nosed bandicoot	10	$10 - 1 = 9$	$10 \times 9 = 90$
southern brown bandicoot	2	$2 - 1 = 1$	$2 \times 1 = 2$
bush rat	12	$12 - 1 = 11$	$12 \times 11 = 132$
dusky antechinus	15	$15 - 1 = 14$	$15 \times 14 = 210$
smoky mouse	5	$5 - 1 = 4$	$5 \times 4 = 20$
	$\sum N = 44$		

- a. Calculate  $\sum n_i(n_i - 1)$  for the mammal species and write your answer in the table above. 1 mark
- b. Given that  $N(N - 1)$  is equal to  $44 \times 43 = 1892$ , use the equation below to calculate Simpson's Index ( $D$ ) for the heathland habitat at Site A. 1 mark

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

$$D = 1 - \frac{\boxed{\phantom{000000}}}{1892}$$

$$D = \boxed{\phantom{0.000000}}$$

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- c. Another similar heathland habitat (Site B) has been investigated and a Simpson’s Index of 0.39 was calculated.

Explain what the index figures indicate about species diversity at the two sites. Include an explanation of species diversity in your answer.

2 marks

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- d. The smoky mouse is endemic to southern Australia and is classified as an endangered species in Victoria. However, a number of people argue that this species deserves less protection than others because it is not as attractive as the bandicoot and that all mice should be considered a pest.

Explain whether this is an ‘anthropocentric’ or an ‘ecocentric’ view, making clear the difference between the two terms.

3 marks

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**Question 2** (10 marks)

The Carpentarian rock-rat (*Zyomys palatalis*) is a small mammal that lives in remnant rainforest patches in rocky sandstone ranges in the Northern Territory. Two isolated populations of fewer than 700 individuals each have been located in this area. Threats to the habitat of the Carpentarian rock-rat are climate change resulting in altered rainfall patterns, changed fire regimes and exotic weeds. Other possible threats are feral cats and cattle grazing. A recovery management plan for the Carpentarian rock-rat has been developed by the Parks and Wildlife Commission of the Northern Territory and the National Heritage Trust.

- a. At present the Carpentarian rock-rat is classified by the International Union for Conservation of Nature (IUCN) as critically endangered. An overall aim of the recovery management plan is to down-list the species.

State a conservation category that would represent an improvement in the species' situation. 1 mark

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- b. Exotic weeds are a key threat to the survival of the Carpentarian rock-rat.

Suggest how exotic weeds might affect the survival of the Carpentarian rock-rat. 2 marks

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- c. Another reason the Carpentarian rock-rat is at risk of extinction is the low genetic variability of the small population in the wild.

Outline **one** reason why low genetic variability within a population increases the likelihood of extinction. 2 marks

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- d.** The recovery management plan outlines a strategy to release captive-bred animals into a new habitat nearby, but separate from the existing populations.

Describe **one** way in which the number of individuals in the released population could be monitored over time.

2 marks

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- e.** An environmental scientist argues that captive-bred animals should be released into the same habitat with the existing populations instead of into a new habitat.

Compare the two strategies, providing the advantages and disadvantages of both.

3 marks

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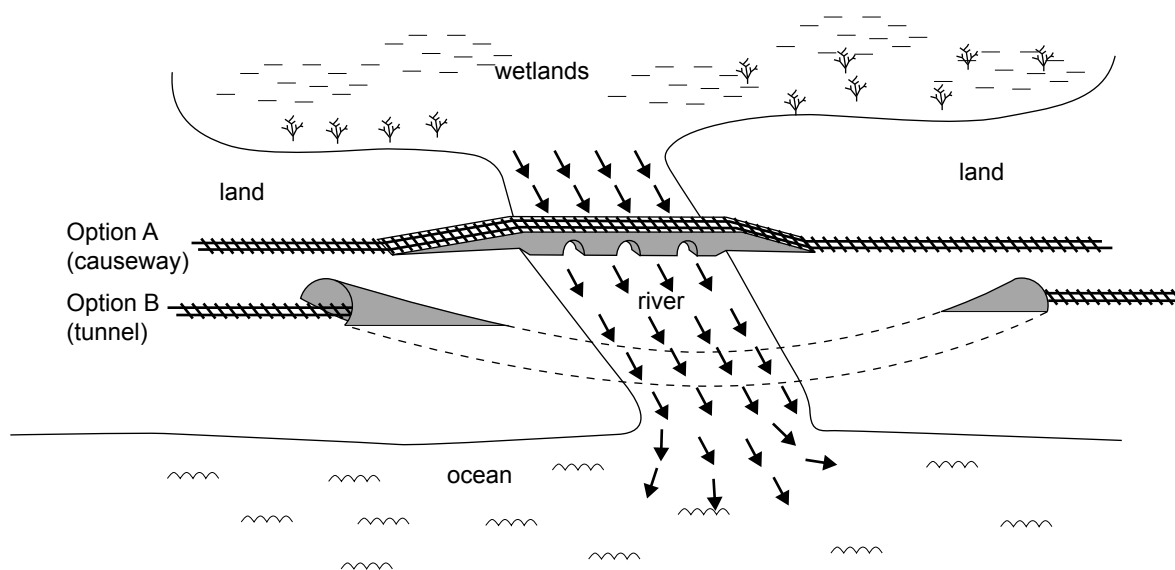
**Question 3** (13 marks)

A new residential development with the potential to house approximately 120 000 people is being developed on a coastal strip of land approximately 8 km from the edge of a major city. To provide transport to this new development, engineers are planning a rail link.

The planned route for this rail link is relatively simple but includes crossing a wide river mouth midway along the route. This river mouth is approximately half a kilometre wide. Upstream from the proposed river crossings is a large wetland area with a significant water bird habitat. The engineers consider two possibilities for crossing this river mouth:

- Option A – a half-kilometre long causeway or built-up embankment with a number of openings to allow the river to flow through
- Option B – a 1 km tunnel to allow the rail link to pass under the river

The two potential crossings are shown in the diagram below.



The cost of the rail link without the river crossings is approximately \$20 million. Option A is costed at approximately \$4 million. Option B is costed at approximately \$50 million.

Arguments presented for and against these options include the following:

- The causeway would lead to great change in the flow of the river. The tide would no longer flush the wetlands and, hence, it may become stagnant.
- If the causeway were built, at times of low flow the wetlands could become very salty, affecting the wildlife.
- The causeway would spoil the view of the ocean from the inland-side of the railway.
- Pollution from the use of cars and other vehicles as the only available mode of transport would affect animal, bird and aquatic life in the area. Therefore, the rail link is essential to provide an environmentally sustainable mode of transport.
- The tunnel is too expensive and, if the causeway were not allowed, the rail link is unlikely to be constructed. This would have environmental consequences as other modes of transport, such as cars, would be used.
- The wetland area would be changed by the causeway but the wildlife (especially the migratory water birds) would quickly adjust.

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a. Is the rail link project an ecologically sustainable development? Justify your response. 2 marks

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b. Key challenges to sustainability include issues related to population, food, water and energy. Select **one** of these key challenges to sustainability and explain how the proposed rail link project aims to meet this challenge. 2 marks

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**c.** Analyse the roles of **two** stakeholder groups involved in encouraging responsible environmental practices throughout the rail link project and identify a value system that affects the decision-making of each stakeholder group.

4 marks

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**d.** You have been asked to recommend either Option A or Option B and you are to use the following sustainability principles as key criteria in your recommendation.

Sustainability principles: intergenerational equity, intragenerational equity, conservation of biodiversity, user pays principle, efficiency of resource use, precautionary principle

Recommend **one** option and justify your choice by evaluating the extent to which each option applies the sustainability principles.

5 marks

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**Question 4 (8 marks)**

Damming a river to construct a reservoir for a hydro-electric power station can have a number of beneficial as well as harmful impacts on the environment.

- a. Describe an environmental benefit to the atmosphere that may occur as a result of constructing a dam and hydro-electric power station system. 2 marks

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- b. Describe a harmful impact on the hydrosphere that may occur as a result of constructing a dam and hydro-electric power station system. 2 marks

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- c. Scientists are developing a management plan for a proposed dam and hydro-electric power station system, and have collected data related to previous river flow and flood patterns, past water temperatures within the river and levels of sediment in the river to use in this plan.  
Explain why the scientists have studied this historical data. 2 marks

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- d. Do damming the river, developing a reservoir and constructing a hydro-electric power station maintain the sustainability principle of ecological integrity? Justify your answer, making clear the meaning of ecological integrity.

2 marks

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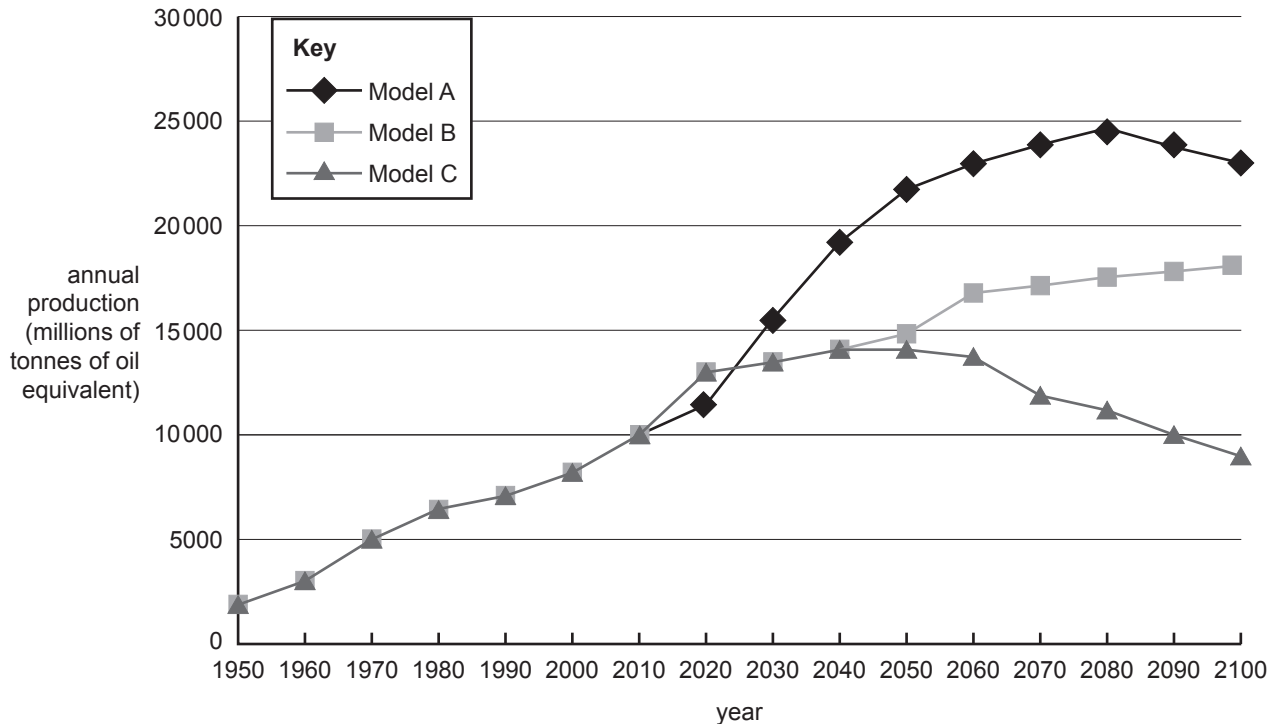
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**Question 5** (6 marks)

Scenario modelling has been used to generate three predictions for energy produced by fossil fuels in the future, as shown in the graph below. Variations in the production levels between the three models are based on different predictions for factors such as population growth, energy-use patterns, economic growth and technological development.

**World primary energy production from fossil fuels**



Source: adapted from M Höök, 'Fuelling Future Emissions – Examining Fossil Fuel Production Outlooks Used in Climate Models', in J Blanco and H Kheradmand (eds), *Climate Change – Research and Technology for Adaptation and Mitigation*, InTech, 6 September 2011, Chapter 3, pp. 50 & 52

- a. Which one of the models shown in the graph has, as part of its modelling program predictions, a high population growth rate, strong economic growth and continuing reliance on fossil fuels in the foreseeable future? Justify your response.

2 marks

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- b. Groups of scientists have presented these different models and have argued about the accuracy of their models.

Why is scenario modelling of this sort used to make predictions about future fossil fuel usage? 2 marks

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- c. Apart from possible variations in demand for energy from fossil fuels in the future, there is also uncertainty about the actual quantities of remaining fossil fuel deposits.

Explain why there is uncertainty when calculating remaining fossil fuel deposits. 2 marks

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**Question 6** (13 marks)

Until recently, a small, isolated, inland town relied on a diesel-powered generation system to provide electricity to its 200 residents and its small businesses. The diesel that was transported to the town by truck was not biodiesel. The nearest coal-fired power station is over 1100 km away and the nearest gas-fired power station is over 700 km away.

The town has constructed a geothermal power station that now provides approximately 30% of its electricity needs. The geothermal power station receives water with a temperature of 98.3 °C from a 1.3 km deep bore. Once the water has been through the power station, it is further cooled in ponds and used to supply the town with water. This is the only use of geothermal energy from this water source.

The bore for the power station takes water from a large aquifer (natural underground water storage) containing water that ranges from several thousand to up to two million years old. Currently, water is being extracted from the aquifer at a much faster rate than it is being replenished, mainly due to its use in agricultural activities, such as crop irrigation and drinking water for cattle. As a result, a number of endemic species and communities that are dependent on the natural discharge of groundwater from the aquifer in the region are listed as vulnerable.

- a. In terms of energy transport and energy efficiency, explain why a diesel-powered generation system was used by the town as a source of electricity rather than coal or natural gas. 2 marks

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- b. Describe the impact on the carbon cycle of using diesel as an energy source. 2 marks

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- c. The diesel for the town’s power station was sourced from an onshore oil drilling rig. There was an oil spill at the rig site.

Explain a mechanical, chemical or biological process that could be used to clean and rehabilitate the site.

2 marks

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- d.
  - i. What is the source of the geothermal energy being used by the town?

1 mark

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- ii. Describe the energy conversion process (including energy forms) that explains how geothermal energy is able to generate electrical energy.

3 marks

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- e. Is the extraction of geothermal energy from the aquifer a sustainable use of this resource? Justify your response using the sustainability principles of ecosystem conservation and intergenerational equity. 3 marks

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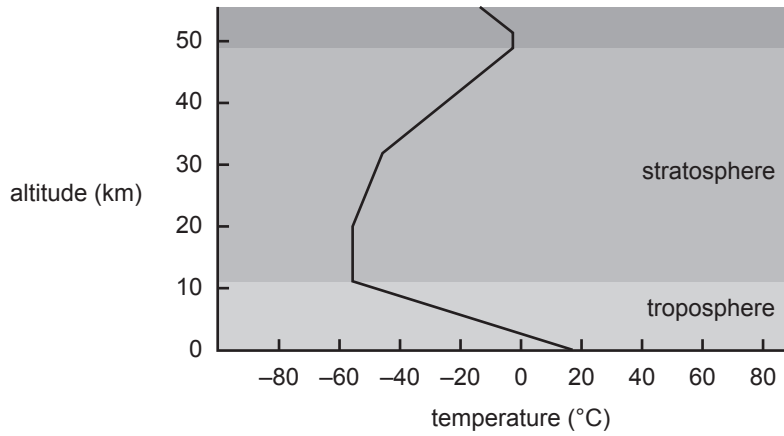
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**SECTION B – continued  
TURN OVER**

**Question 7** (12 marks)



Source: adapted from [www.weather-climate.org.uk/02.php](http://www.weather-climate.org.uk/02.php)

- a. The graph above shows how the temperature of the atmosphere varies with altitude.

Describe how the temperature changes as the graph moves upwards from the ground to the top of the stratosphere.

2 marks

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- b. If the atmosphere contained only nitrogen gas and oxygen gas, the average temperature at the surface of Earth would be approximately  $-17\text{ }^{\circ}\text{C}$ . The current average temperature at the surface of Earth is approximately  $16\text{ }^{\circ}\text{C}$ .

List **two** gases in the atmosphere that naturally maintain warmer surface conditions and explain how they do so.

3 marks

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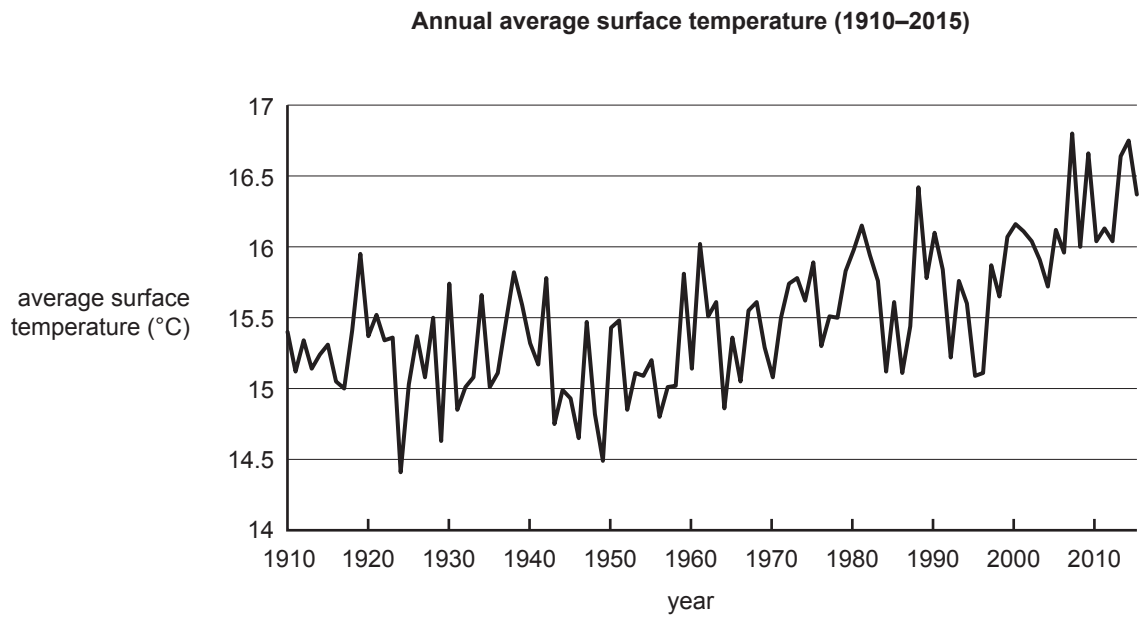
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The graph below shows a town’s annual average surface temperature each year from 1910 to 2015.



c. Describe the overall trend in temperatures over the years shown in the graph. 2 marks

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d. Explain the changes to the atmosphere that are likely to have caused the overall trend described in part c. 2 marks

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- e. A student argues that the average temperature in 1919 was approximately 16 °C and in 1995 the average temperature was approximately 15 °C, so the town's temperature has fallen over the past 100 years.

Is this student's argument correct or not? Explain your response.

3 marks

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**SECTION B – continued**  
**TURN OVER**

**Question 8** (9 marks)

In 2013, scientists analysed a 3 km long core of ice drilled in Greenland. The ice core provided information about changes that have occurred over the past 130 000 years.

- a. Describe how scientists can use ice cores to determine the past composition and temperature of the atmosphere.

3 marks

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- b. Briefly describe a technique, other than ice core analysis, for measuring and understanding past changes in the atmosphere.

2 marks

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**Question 9** (12 marks)

A group of students wants to model the effect of global warming on seawater. The students tested the hypothesis that if water temperature increases by 10 °C, water volume will increase. They used a test tube filled with 10.0 mL of fresh (distilled) water at 20 °C and slowly heated this test tube using a Bunsen burner. They noted the change in volume when the water was heated by 10 °C. They repeated this experiment five times (five trials). They also used a control test tube that was not heated.

**Results**

Trial	Initial volume (mL)	Final volume (mL)	Change in water volume (mL)
1	10.0	12.0	2.0
2	10.0	13.0	3.0
3	10.0	12.0	2.0
4	10.0	11.0	1.0
5	10.0	13.0	3.0
<b>Control test tube (not heated)</b>	10.0	10.0	0.0

- a. Explain the purpose of the control test tube in this experiment.

1 mark

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- b. Calculate the average (mean) change in the volume of the water. Do **not** include the results for the control test tube in your calculation.

1 mark

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c. Explain how this experiment relates to global warming and global sea levels. 2 marks

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d. State **one** improvement that could be made to this experiment and explain how this would improve the validity of the experiment. 2 marks

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e. Explain, using the changes in water volume obtained, the importance of repeating the experiment five times. Include the term ‘reliability’ in your answer. 2 marks

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**Answers to multiple-choice questions**

Question	Answer
1	D
2	D
3	D
4	D
5	C
6	B
7	C
8	B
9	D
10	D
11	D
12	C
13	B
14	C
15	D

Question	Answer
16	D
17	A
18	B
19	A
20	C
21	B
22	A
23	D
24	A
25	D
26	D
27	A
28	A
29	A
30	B