



Victorian Certificate of Education 2004

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Letter

Figures

Words

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ENVIRONMENTAL SCIENCE

Written examination 1

Tuesday 8 June 2004

Reading time: 2.45 pm to 3.00 pm (15 minutes)

Writing time: 3.00 pm to 4.30 pm (1 hour 30 minutes)

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	20	20	20
B	6	6	70
			Total 90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, an approved graphics calculator (memory cleared) and/or one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 17 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 electronic communication 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 of the following is the best example of a vegetation sink?

- A. a compost heap
- B. a large body of water
- C. a large plantation of sugar cane
- D. a biomass-powered generating plant

Question 2

Which group contains only renewable energy sources?

- A. solar, wind, coal
- B. tidal, natural gas, wind
- C. geothermal, hydroelectric, tidal
- D. hydroelectric, uranium, natural gas

Question 3

Which group contains only fossil energy sources?

- A. biomass, coal, oil
- B. coal, oil, natural gas
- C. geothermal, coal, oil
- D. uranium, natural gas, coal

Question 4

Which of the following is an endothermic reaction?

- A. melting ice
- B. burning a candle
- C. operating a petrol engine
- D. condensing steam to liquid water

Question 5

Which of the following human activities does **not** contribute to the enhanced greenhouse effect?

- A. deforestation
- B. coal-burning power stations
- C. use of ethanol from biomass
- D. use of solar pool-heating systems

The following information relates to Questions 6–8.

A large natural gas field is located just outside the city of Browntown.

The Browntown City Council wants to use the local natural gas supplies as the fuel source for the local public transport system. They have employed an engineer to evaluate the following two options.

Option A: Natural gas is used directly as the fuel for the city's buses.

Option B: Natural gas is used to generate electricity to power an electric tramway system.

Under **Option A** (gas-fuelled buses), for every joule of energy put in by the natural gas, the bus produces 0.25 joules of work as motion.

Question 6

Most of the energy that is not converted to motion becomes

- A. chemical energy.
- B. potential energy.
- C. a reusable energy source.
- D. heat through exhaust gas and friction.

In **Option B** natural gas is used in a power station. A natural gas boiler provides steam to a turbine, which drives an electric generator. The electricity is then distributed through overhead wires to electric trams.

- The power station is 70% efficient.
- The distribution system is 90% efficient.
- The motors of the electric trams are 80% efficient.

Question 7

What is the best estimate of the overall efficiency of the electric tramway system described in **Option B**?

- A. 240%
- B. 75%
- C. 50%
- D. 24%

The engineer needs to evaluate the capital costs of the equipment mentioned below of each option. She obtains the following information.

- Each tram or bus costs \$1 000 000.
- Either 20 **buses** or 20 **trams** will be required to provide the service.
- Under **Option B**, the cost of the power station, tracks and distribution system for the trams is \$20 000 000.
- Each **tram** has a usable life of 40 years, and each **bus** 10 years.
- The electric power station, tracks and distribution system for the trams have a life of 40 years.

Question 8

Which statement describes the comparative costs of equipment for the two options over 40 years?

- A. Option A (buses) is ten times that of Option B (trams).
- B. Option A (buses) is twice that of Option B (trams).
- C. Option A (buses) is the same as that of Option B (trams).
- D. Option A (buses) is half that of Option B (trams).

Question 9

Emissions Trading allows countries or companies to buy and sell amounts of allowable emissions of greenhouse gases.

Which of the following is an example of Emissions Trading?

- A. a power station emitting surplus heat as infrared radiation rather than ultraviolet
- B. a city using electric-powered buses in place of diesel buses for public transport
- C. a forest plantation company planting trees and selling credits to a power-generating company
- D. a power-generating company using natural gas in place of oil to reduce greenhouse gas emissions

Question 10

Genetic diversity of a species is best described as

- A. the rate of genetic drift.
- B. the number of different species in an ecosystem.
- C. genetic variation between different individuals of a species.
- D. the relative population sizes of different species in an ecosystem.

Question 11

Species diversity in an ecosystem is best determined by measuring

- A. the total number of individuals in an ecosystem.
- B. the number of species and their relative population sizes.
- C. the genetic differences within each of the species in the ecosystem.
- D. the number of different habitats occupied by one particular species.

Question 12

What is endemism?

- A. absence of genetic diversity in a species
- B. restriction of a species to a particular location
- C. dominance of one species in a particular location
- D. unsuitability of an ecosystem for a particular species

Question 13

Genetic swamping is most likely to occur when

- A. a species moves into a different ecosystem.
- B. a number of previously isolated species come in contact.
- C. geographic isolation of a population of a species leads to inbreeding.
- D. a small, previously isolated population of a species comes in contact with a larger population.

Question 14

The conservation status of a species gets worse when it changes from

- A. critical to vulnerable.
- B. endangered to critical.
- C. critical to endangered.
- D. endangered to vulnerable.

Question 15

What is inbreeding?

- A. breeding between different species
- B. breeding attempts that are unsuccessful
- C. breeding in very large populations of a species
- D. breeding between individuals that are genetically related

Question 16

The main aim of a captive breeding program for an endangered species is to increase

- A. species diversity.
- B. ecosystem diversity.
- C. the population to viable numbers.
- D. the genetic diversity of the population.

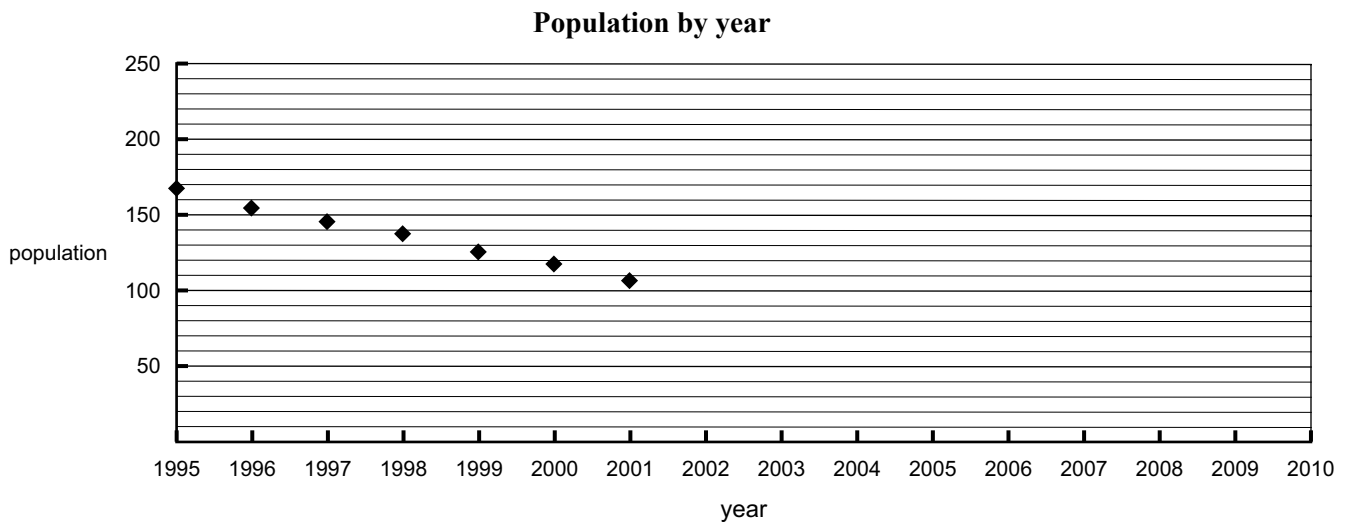
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The following information refers to Questions 17–20.

A scientist is monitoring the population of a small animal in a habitat fragment surrounded by housing estates. The sampling is done annually, at the same time of the year.

He samples by counting the number of the species observed over a six-hour period each night for a fortnight. From the sampling the population of the habitat is determined.

The data collected is shown below.



Question 17

What is the best estimate of the percentage decrease in the population between 1995 and 2000?

- A. 3%
- B. 30%
- C. 50%
- D. 130%

Question 18

The minimum viable population for this species is considered to be 50 individuals.

On current trends, when will the population reach this level?

- A. 2003
- B. 2007
- C. 2010
- D. 2017

Question 19

Which of the following is a likely cause of the population decrease?

- A. inbreeding
- B. endemism
- C. biodiversity
- D. genetic swamping

Question 20

Park managers remove some of these small animals from this habitat fragment and breed them in captivity. Their offspring will be released to another site that was previously occupied by the species.

By reintroducing the small animals, what would the park managers hope to increase?

- A. the demographic variation
- B. the genetic drift of the small animals
- C. the species diversity at the new site
- D. the exotic competitors of the small animals

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**END OF SECTION A
TURN OVER**

SECTION B – Short-answer questions**Instructions for Section B**

Answer **all** questions in the spaces provided.

Question 1

- a. Name one fossil energy source and one non-fossil energy source. Describe the emissions, if any, from these energy sources.

3 marks

- b. Ultraviolet, visible and infrared radiation are absorbed differently in the atmosphere. Explain how this helps our understanding of the greenhouse effect. You may include a diagram in your response.

4 marks

- c. Explain how the **fossil energy** source that you have named in part **a.** contributes to the enhanced greenhouse effect, as its emissions interact with infrared, visible and ultraviolet radiation in the atmosphere.

3 marks

- d. Outline one disadvantage of the use of the **non-fossil energy source** you have named in part **a.**

2 marks

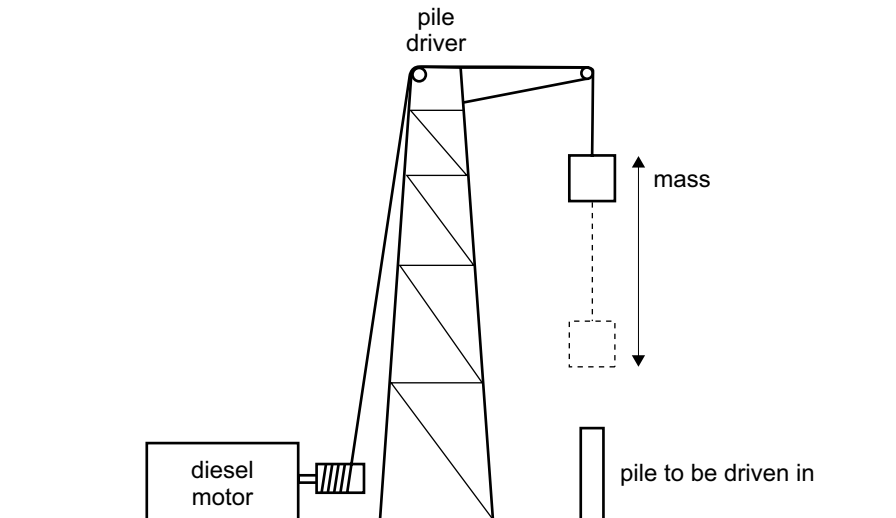
- e. Describe one impact of land use changes on the enhanced greenhouse effect.

2 marks

Total 14 marks

Question 2

An engineering company constructs pile drivers. This machine has a large mass that is lifted by a diesel motor. As the mass falls, it drives (pushes) the pile into the ground. Refer to the diagram below.



- a. Describe three energy transformations that occur as the operation of the diesel motor raises the mass to its top position.

3 marks

- b. Refer to the pile driver to explain the difference between potential energy and kinetic energy.

4 marks

Each litre of diesel fuel can generate 37 800 kJ of energy. However, only 7 560 kJ of work is done by the pile driver for each litre of diesel fuel burnt in the engine.

- c. Calculate the efficiency of energy conversion in the pile driver. Show working.

2 marks

- d. The first law of thermodynamics implies that energy is neither created nor destroyed. Explain how this law applies to the operation of the diesel engine in the pile driver.

3 marks

The engineering company introduces a new motor powered by an engine that uses wood as a fuel rather than diesel. The company advertises that

‘Wood, as a renewable fuel, is more environmentally friendly than diesel’.

- e. Describe the implications of this fuel choice for global warming.

4 marks

Total 16 marks

SECTION B – continued
TURN OVER

Question 3

Compare one renewable and one nonrenewable source with respect to their usefulness for providing the energy needs of a small town. Your answer should address each of the following.

- relative energy efficiencies
- economic considerations over the life of the equipment
- environmental impacts

You must name the renewable and nonrenewable energy source you are comparing in the spaces provided below.

Renewable source _____

Nonrenewable source _____

[illegible]

6 marks

Total 6 marks

Question 4

A subspecies of an Australian bird is identified in a large wetland ecosystem in northeastern Victoria. The subspecies is found to be endemic to this area.

- a. The fact that the subspecies is endemic to this area makes it more in need of protection. Explain why.

3 marks

An environmental scientist undertakes a 'Population Viability Analysis' of the subspecies in this location.

- b. Explain the term Population Viability Analysis as it applies to this situation.

2 marks

Under the Ramsar Convention, to which Australia is a signatory, we are required to protect wetland ecosystems and their species.

The scientist finds that the population of the bird subspecies is nonviable and hence at risk of extinction.

- c. Outline two possible strategies for protecting the population, with particular reference to this subspecies in this location.

4 marks

Total 9 marks

Question 5

A study is undertaken of a small national park. The park was previously situated next to extensive areas of native vegetation, but is now completely surrounded by housing estates.

A small native animal in the park is classified as ‘vulnerable’.

- a.** Explain the term vulnerable in terms of conservation categories.

2 marks

- b.** Identify and describe two possible threats to the survival of the population of this animal.

4 marks

- c.** Recommend two strategies for managing the population that respond positively to the threats described in part **b.** Explain how each would help.

4 marks

Total 10 marks

SECTION B – continued

Question 6

In 1992 Australia signed the United Nations Convention on Biodiversity. One of the obligations of a national government under this convention is to monitor biodiversity, especially in threatened ecosystems.

A biologist, Gillian, is contracted by the government to assess the impact of recreational fishing on a lake system through which a major river flows.

She asks five local people to monitor the number of fish caught over a four-hour period on five successive days each year. They each record their total catches over the five-day period as follows.

	1998	1999	2000	2001	2002
Albert	14	15	13	16	15
Bert	13	16	18	14	12
Cindy	16	13	15	13	18
David	17	14	13	15	13
Elizabeth	15	15	17	17	17
Total					

- a. Calculate the average number of fish caught per person for 2001. Show your working.

2 marks

- b. With reference to the total catch per year, and variation between years, comment on the adequacy of Gillian's sampling for assessing the impact of fishing.

2 marks

Gillian also records the species of the catches. The data for 1998 and 2002 are shown below.

	1. Murray cod	2. Silver perch	3. European carp	4. Other species	Total
1998	20	15	15	25	75
2002	5	10	40	20	75

Gillian uses Simpson's Diversity index (D) to evaluate the biodiversity as required by the convention.

Simpson's index is a measure of biodiversity. Higher Simpson's index indicates greater biodiversity. For the case of the four species above, Simpson's index is given by the formula

$$D = 1 - (p_1^2 + p_2^2 + p_3^2 + p_4^2)$$

$$\text{where } p_1 = \frac{\text{number of individuals of species 1}}{\text{total number of individuals of all species}}$$

- c. Complete the tables below to estimate Simpson's index for the years 1998 and 2002.

Show your working by filling in the columns.

1998

Species	No. of Individuals	$p = \frac{\text{number of individuals of this species}}{\text{total number of individuals of all species}}$	p^2
Murray cod	20		
Silver perch	15		
Euro carp	15		
Other	25		
Total	75		Total $p^2 =$

$$D = 1 - \text{Total } p^2 = \boxed{}$$

2002

Species	No. of Individuals	$p = \frac{\text{number of individuals of this species}}{\text{total number of individuals of all species}}$	p^2
Murray cod	5		
Silver perch	10		
Euro carp	40		
Other	20		
Total	75		Total $p^2 =$

$$D = 1 - \text{Total } p^2 = \boxed{}$$

4 marks

- d. Albert, one of the fishermen, argues that since the number of fish caught has not changed over the five-year period 1998–2002, fishing should be allowed to continue.
Gillian, the biologist, argues that there has been a change in biodiversity, as shown by Simpson's index. Comment on these arguments. Your answer should include a reference to what the calculated Simpson's indexes indicate.

3 marks

- e. Outline two possible strategies that Gillian could suggest to the government to maintain the biodiversity of the lakes system.

4 marks

Total 15 marks