



Victorian Certificate of Education 2013

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Letter

Figures

Words

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ENVIRONMENTAL SCIENCE

Written examination

Monday 11 November 2013

Reading time: 3.00 pm to 3.15 pm (15 minutes)

Writing time: 3.15 pm to 5.15 pm (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	6	6	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 white out liquid/tape.

Materials supplied

- Question and answer book of 27 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 includes only fossil fuels?

- A. oil, coal, wood, petrol
- B. petrol, oil, natural gas, coal
- C. natural gas, coal, oil, wood
- D. natural gas, uranium, oil, coal

Use the following information to answer Questions 2–6.

A species of marsupial was thought to be extinct. Then, in the 1970s, two separate populations were discovered in a remote area. One of these (population A) had approximately 200 individuals (including 50 breeding pairs) and the other (population B) had approximately 30 individuals (including 12 breeding pairs). A recovery program was begun. This involved both a captive breeding program and relocation to suitable but separate habitats. The program has been successful.

The following table gives the total numbers over a 20-year period.

Year	1975	1980	1985	1990	1995
Total number	250	300	400	800	1600

Question 2

The percentage increase from 1985 to 1995 can best be expressed as

- A. 4%
- B. 30%
- C. 120%
- D. 300%

SECTION A – continued

Question 3

Initially, one ranger suggested combining the two populations, A and B, as the habitat with the larger number of marsupials was obviously the more suitable habitat, as shown by its larger population. However, one scientist opposed this move.

The most likely reason for the scientist opposing the ranger's suggestion would be to avoid

- A. inbreeding.
- B. genetic drift.
- C. genetic diversity.
- D. genetic swamping.

Question 4

In 1995, the conservation status of the species was changed.

Which one of the following is the most likely change?

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

Question 5

The probability of extinction of population A was assessed at 0.20 and that of population B at 0.60.

Which one of the following is the best estimate of the probability of extinction of both populations?

- A. 1.20
- B. 0.80
- C. 0.40
- D. 0.12

Question 6

For the initial captive breeding program, five breeding pairs were taken from population A and three breeding pairs from population B.

Selecting from both populations was most likely done in order to

- A. increase competition.
- B. prevent species extinction.
- C. maintain genetic diversity.
- D. prevent demographic variation.

Question 7

Genetic diversity is best measured by assessing

- A. the relative risk of extinction of different species within the habitat.
- B. the number of different species within the habitat.
- C. small variations within a particular species.
- D. the relative abundance of the species.

SECTION A – continued
TURN OVER

Question 8

Species diversity in a habitat is best measured by developing an index that is based on the

- A. number of species and the relative abundance of each species in the habitat.
- B. total number of species within a particular habitat.
- C. total number of individuals within the habitat.
- D. number of different ecosystems in the habitat.

Use the following information to answer Questions 9–12.

A road authority is building a freeway to bypass a country town. Its route goes through the middle of a very large wetland.

The government requires an environmental impact statement (EIS) for the project.

Question 9

Which one of the following must be included in the EIS?

- A. the financial viability of the project for the construction company
- B. the effect on businesses in the bypassed town
- C. the impact on land values in the town
- D. the impact on wildlife in the wetlands

Question 10

A frog species in the wetland is classified as vulnerable.

This classification means that

- A. the frog is found only in this location, so it will be extinct if this habitat is destroyed.
- B. the frog is facing an extremely high risk of extinction in the wild in the immediate future.
- C. the frog is not endangered, but is facing a high risk of extinction in the medium-term future.
- D. there is insufficient data to classify the frog as endangered or critical, so it must be protected.

Question 11

A scientist who is involved in preparing the EIS wants tunnels, with water and reeds in them, to be built at several points under the freeway.

These tunnels are best described as

- A. wildlife corridors.
- B. remnant vegetation.
- C. soil remediation and erosion protection.
- D. an application of the precautionary principle.

Question 12

The main purpose of the tunnels is most likely to

- A. reduce inbreeding.
- B. avoid demographic variation.
- C. avoid criticism from conservationists.
- D. enable tourists to observe the vulnerable frogs in the tunnels.

SECTION A – continued

NO WRITING ALLOWED IN THIS AREA

Question 13

A company changes from using natural gas to using wood to generate steam for its plant.

This action can best be described as a change from

- A. fossil fuel to biomass fuel.
- B. non-fossil fuel to fossil fuel.
- C. renewable energy to fossil fuel.
- D. non-fossil fuel to renewable energy.

Question 14

Cold packs that are used for first aid contain chemicals that lower temperature when they react together.

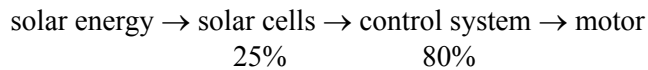
This reaction is best termed

- A. biological.
- B. exothermic.
- C. mechanical.
- D. endothermic.

SECTION A – continued
TURN OVER

Use the following information to answer Questions 15–17.

Alex uses solar cells to power her electric car. The energy conversions and their efficiencies are shown in the following diagram.



The solar energy striking the car's solar cells is 800 watts.

Question 15

What is the energy used by the motor at top speed (maximum efficiency)?

- A.** 160 watts
B. 180 watts
C. 800 watts
D. 2400 watts

Question 16

Which one of the following represents a form of energy loss in the electric car during the process in which sunlight is converted into motion?

- A.** speed
B. heat energy
C. kinetic energy
D. mechanical energy

Question 17

In a different type of electric car, the motor is powered by a battery instead of solar cells.

The main energy transformation that takes place between the battery and the motor is

- A.** electrical energy to chemical energy.
B. kinetic energy to mechanical energy.
C. chemical energy to mechanical energy.
D. chemical energy to endothermic energy.

Question 18

The gas that contributes the most overall to the **enhanced** greenhouse effect on Earth is

- A.** ozone.
- B.** methane.
- C.** carbon dioxide.
- D.** chlorofluorocarbon-11.

Question 19

Which one of the following is **not** a greenhouse gas?

- A. oxygen
B. water vapour
C. nitrous oxide
D. carbon dioxide

Question 20

Which one of the following statements about elemental mercury is true?

- A. It dissolves readily in water.
- B. It is a solid at room temperature.
- C. It is less dense than sulfur dioxide.
- D. It can be absorbed through the skin.

Question 21

Mercury oxide can be converted to methyl mercury by

- A. settling in soil.
- B. bacteria in lakes.
- C. reacting with water.
- D. reacting with oxygen.

Question 22

The most likely effect of excessive mercury on human health is

- A. breakdown of lung tissue.
- B. shrinking of limbs.
- C. muscle weakness.
- D. damage to teeth.

Question 23

Bioaccumulation occurs when

- A. the food chain breaks down.
- B. salts accumulate in soil, preventing seed germination.
- C. substances increase in concentration in certain organisms.
- D. greenhouse gases increase in concentration in the atmosphere.

Question 24

Which one of the following best describes a synergistic effect?

- A. treating polluted soil with two methods of remediation
- B. a management strategy that involves reducing and recycling
- C. the combined effect is more than the sum of the individual effects
- D. implementing procedures that minimise environmental harm where there is risk

Question 25

Certain pollutants are persistent in the environment.

Which of the following is most likely to be correct?

The pollutants

- A. are heavy metals.
- B. are readily soluble in water.
- C. have immediate toxic effects only.
- D. can be easily broken down by microorganisms.

SECTION A – continued
TURN OVER

Use the following information to answer Questions 26–28.

A logging company sets up an operation in a large state forest that is next to a river. A wetland is located on the river's flood plain. The wetland is a habitat for platypuses and other aquatic organisms. Before it begins logging, the company sets up a base camp where machinery, such as trucks, bulldozers and generators, is kept. Diesel fuel is stored in a tank for use in these machines.

A tree falls, causing a hole in the bottom of the full diesel tank. Diesel leaks out at a constant rate of 265 litres per hour.

The diesel floats on the surface of the water in the wetland.

Question 26

A total of 7200 litres of the leaked diesel drains into the wetland. Diesel is volatile and vaporises into the atmosphere. After three days, 75% of the volume has evaporated.

How much diesel is still floating on the surface of the wetland after three days?

- A. 1800 litres
- B. 5400 litres
- C. 7000 litres
- D. 7200 litres

Question 27

Microorganisms in the water will continuously break down the diesel over a period of months.

This is an example of

- A. bioremediation.
- B. bioaccumulation.
- C. synergistic action.
- D. waste minimisation.

Question 28

The platypus is not listed (as threatened) under the *Flora and Fauna Guarantee Act 1988*.

According to the precautionary principle, which one of the following actions is the most desirable?

- A. More monitoring and research is required to collect data on the platypus.
- B. The platypus should now be reclassified as threatened because of the diesel spill.
- C. The platypus should still be protected because total population estimates are uncertain.
- D. The logging company should not be penalised for causing harm to the habitat of a relatively common and non-threatened species.

NO WRITING ALLOWED IN THIS AREA

SECTION A – continued

Use the following information to answer Questions 29 and 30.

A major electronics company conducts a Life Cycle Assessment (Analysis) of the refrigerators that it produces. The company considers energy efficiency, pollutants released during the manufacturing process and the sources of materials that are used in the manufacturing process.

Question 29

As part of this, the company should also

- A. investigate methods of disposal of old refrigerators, including recycling.
- B. consult consumer groups regarding the visual appeal of the refrigerators.
- C. develop new markets for the refrigerator, to extend its manufacturing life.
- D. consider the economic risks of developing improved types of refrigerators.

Question 30

The company changes the process for manufacturing the frames of the refrigerators so that less material has to be trimmed off.

This is best described as an example of

- A. hazard avoidance.
- B. waste minimisation.
- C. the precautionary principle.
- D. compliance with regulatory frameworks.

**END OF SECTION A
TURN OVER**

SECTION B

Instructions for Section B

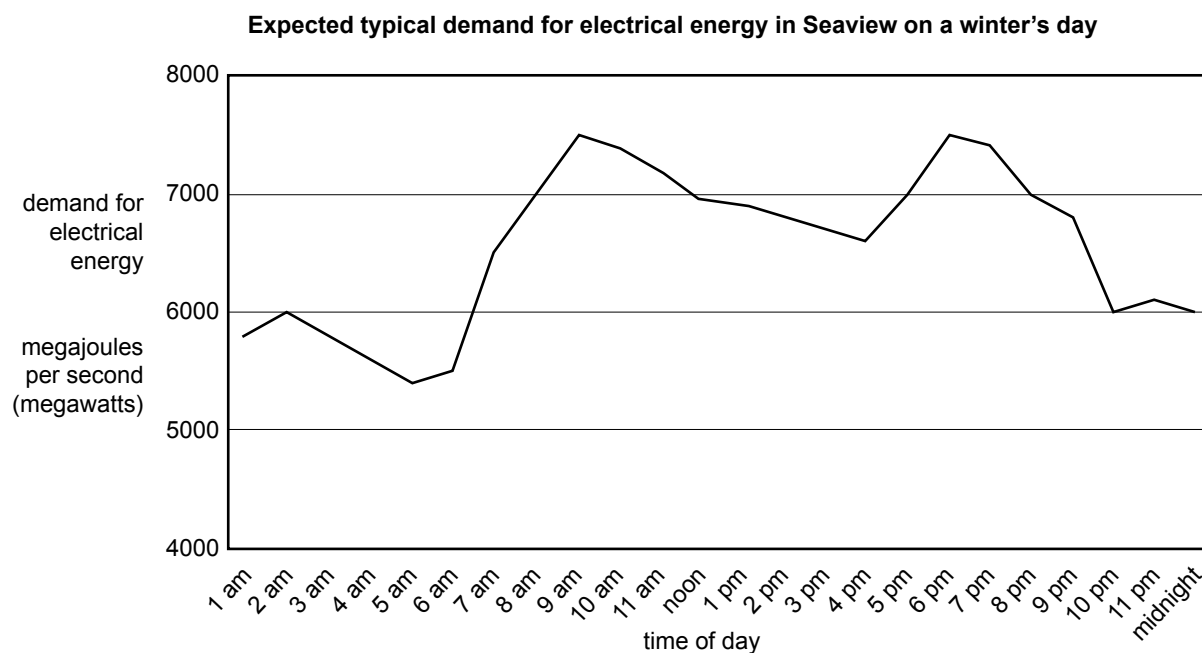
Answer **all** questions in the spaces provided. Write using black or blue pen.

Question 1 (14 marks)

There are plans for a new, large, coastal city, Seaview, capable of accommodating 400 000 people and with extensive infrastructure. This infrastructure will include homes, offices, industries, roads, electric rail transport and a port.

The government seeks to make Seaview as energy efficient as possible.

The following graph shows the expected typical energy demand of the city over 24 hours on a winter's day.



- a. Explain the likely cause of the various times of high and low consumption.

2 marks

SECTION B – Question 1 – continued

- b.** Name a fossil fuel and a non-fossil fuel energy resource that you have studied.

fossil fuel energy resource _____

non-fossil fuel energy resource _____

- i.** Describe how you could use the **fossil fuel** energy resource as a contribution to Seaview's energy needs. In your description, indicate how the fuel could be obtained, how it could generate electricity or be otherwise used, and the infrastructure that would be needed.

3 marks

- ii.** Describe how you could use the **non-fossil fuel** energy resource as a contribution to Seaview's energy needs. In your description, indicate how the fuel could be obtained, how it could generate electricity or be otherwise used, the period each day when it would be most useful, and the infrastructure that would be needed.

4 marks

SECTION B – Question 1 – continued
TURN OVER

- c. Describe **two** environmental impacts of the sourcing, conversion, distribution or use of your nominated **non-fossil fuel** energy resource.

3 marks

- d. What steps could be taken to increase the energy efficiency of **one** of your energy resources?

2 marks

NO WRITING ALLOWED IN THIS AREA

SECTION B – continued

Question 2 (11 marks)

a. Explain the mechanism of the **natural** greenhouse effect. Include a diagram(s).

3 marks

SECTION B – Question 2 – continued
TURN OVER

- b.** Outline the difference between the natural greenhouse effect and the enhanced greenhouse effect. 2 marks

- c.** The measured concentrations of carbon dioxide in the lower atmosphere have increased significantly over the last 50 years.
Suggest reasons for this increase. 2 marks

- d.** Name two greenhouse gases, other than carbon dioxide, that contribute to the enhanced greenhouse effect. For each gas, identify a human activity that has led to an increase in each of these gases. 2 marks

1. gas _____
human activity _____

2. gas _____
human activity _____

SECTION B – Question 2 – continued

- e. Outline **two** likely impacts of the enhanced greenhouse effect.

2 marks

SECTION B – continued
TURN OVER

Question 3 (24 marks)

Coal-fired power stations account for a large percentage of electricity production. One such power station produces sulfur dioxide (SO₂) as a waste product. The pollutant levels of nearby soil and lakes are continuously monitored.

Flora and fauna numbers are also recorded. According to the Environmental Impact Assessment that was carried out in 2001, vegetation surrounding the power station showed an overall decrease in diversity from when the station was commissioned in 1971. An Environmental Management Plan was implemented in 2008.

- a.** Describe how sulfur dioxide is formed. 3 marks

- b.** Is the power station a point source or diffuse source of sulfur dioxide? Give a reason for your answer. 2 marks

- c.** Describe the characteristics of sulfur dioxide that may contribute to it being labelled a pollutant in this scenario. Your answer should refer to factors that define a material as a pollutant. 3 marks

SECTION B – Question 3 – continued

- d. Describe **two** transport mechanisms of sulfur after it is released from the power station.

3 marks

- e. Staff at the power station undergo regular health checks, although their low exposure to sulfur dioxide results in the staff receiving a low dosage of the toxin.

Explain the difference between the terms 'exposure' and 'dosage' with reference to the inhalation of sulfur dioxide.

3 marks

- f. Outline **two** key stakeholders that should have been consulted as part of the development of the power station's Environmental Impact Assessment.

2 marks

SECTION B – Question 3 – continued
TURN OVER

- g.** Describe **two** strategies that the Environmental Management Plan could have included. How might these strategies reduce the environmental risks that exist at the power station?

4 marks

- h.** Geraldine argues that the power station will be an example of ecologically sustainable development (ESD) once carbon sequestration measures are put in place to remove and store the greenhouse gases that are emitted from the station. Paul argues that the power station is not an example of ESD because the power source cannot be replaced as quickly as it is used.

Provide your own argument as to whether a coal-fired power station can be an example of ESD.

Ensure that you include the principles of ESD in your answer.

4 marks

NO WRITING ALLOWED IN THIS AREA

SECTION B – continued

NO WRITING ALLOWED IN THIS AREA

CONTINUES OVER PAGE

SECTION B – continued
TURN OVER

Question 4 (19 marks)

The bridled nail-tail wallaby survives in only three populations in central Queensland. There are thought to be between 400 and 600 wallabies. The majority (about 80%) are believed to be in the Taunton National Park population. Two other much smaller populations are in the same general area, but are completely isolated from the large central population. The populations are stable or slightly increasing.

The bridled nail-tail wallaby species formerly existed across large areas extending from northern Queensland to southern New South Wales, west of the Great Dividing Range. The species was thought to be extinct in the 1930s, but a remnant population was discovered in 1973 and the two other populations have since been found.

The wallaby feeds on native grasses and plants, hence, in the early 20th century, it was hunted as it was considered to be in competition with livestock for feed, but hunting has now ceased. The wallaby lives for about 6–8 years in the wild and 10–15 years in captivity, although there are none in captivity currently.

This wallaby is unusual in that its immune system seems to be much more resilient to infections, viruses and diseases than that of other marsupials.

The main threats to this wallaby are

- land clearing
- destruction of habitat by fires
- dingoes and other predators
- exotic grasses, such as buffel grass, replacing the native grasses on which it feeds.

- a. Maria, a National Parks officer, is proposing a plan to relocate 15 males and 30 females to a new habitat in central New South Wales, some 1200 kilometres south of their present habitat.

Alan argues that this habitat may not be suitable as it is so far removed. He suggests that a fourth population should be established in a habitat very close to, but distinct from, the existing ones. A closer habitat is more likely to be suitable.

Evaluate the reasons for and against Maria's and Alan's proposals.

4 marks

SECTION B – Question 4 – continued

- b. Alan states that all the wallabies for the relocation should be taken from the Taunton National Park population as this was by far the biggest population and the removal of these wallabies would have the least effect. Maria argues for taking them from all three wallaby populations.

Which one of the plans suggested should be followed? Give a recommendation, with reasons for your answer.

4 marks

- c. A management plan is being developed for the bridled nail-tail wallaby.
Referring to the information at the start of Question 4, suggest **two** strategies, other than relocation in the wild, which could be part of that plan.

4 marks

SECTION B – Question 4 – continued
TURN OVER

- d. Rangers decide that it is important to determine more accurately the number of bridled nail-tail wallabies in Taunton National Park. However, resources to do this are limited.
Outline a suitable strategy for more accurately determining the number of bridled nail-tail wallabies in the park.

3 marks

- e. A biologist has argued that species with very restricted numbers are not worth the effort of saving, especially when they are very similar to another species, as the bridled nail-tail wallaby is. He argues that the resources are better allocated to a species that has a greater chance of survival. This is supported by some research that shows that, below a critical number, long-term survival is very unlikely. He argues that the resources to be devoted to the bridled nail-tail wallaby would be better put into a population of another species in northern Queensland. This other species is, and has always been, endemic to a small region in northern Queensland.

- i. What is meant by the expression ‘endemic to northern Queensland’?

2 marks

- ii. Based on and referring to the information at the start of Question 4, give **one** reason why the bridled nail-tail wallaby may be more likely to survive than the other, more numerous species.

2 marks

NO WRITING ALLOWED IN THIS AREA

SECTION B – continued

Question 5 (13 marks)

Scientists are studying three large lagoons open to the sea. These are habitats for a large number and variety of waterbirds, both permanent inhabitants and migratory. Many of these waterbirds nest on the extensive, low mudflats just above the high-tide mark, between the water's edge and the base of cliffs.

The scientists are determining the species richness, relative abundance and species diversity of each wetland habitat.

- a. Indicate which of the terms, 'species richness', 'relative abundance' and 'species diversity', is the most significant for assessing biodiversity. Give reasons for your answer.

4 marks

SECTION B – Question 5 – continued
TURN OVER

The scientists are using an index of diversity to compare the three lagoons.

The index is given by

$$I = \frac{\text{sum of absolute (positive) differences from mean}}{\text{number of species}}$$

The **lower** the index, the greater the diversity.

The scientists gather the following data.

Species	Lagoon A	Lagoon B	Lagoon C
Yellow-bellied Spoonbill	20	10	2
Black-faced Cormorant	25	80	70
Fairy Tern	20	20	36
Grey Teal	15	10	40
Cape Barren Goose	20	20	2

They use the following table to calculate the index for lagoon C.

Species	Lagoon A		Lagoon B		Lagoon C	
	number of individuals	difference from mean	number of individuals	difference from mean	number of individuals	difference from mean
Yellow-bellied Spoonbill	20		10		2	28
Black-faced Cormorant	25		80		70	40
Fairy Tern	20		20		36	6
Grey Teal	15		10		40	10
Cape Barren Goose	20		20		2	28

Mean			$\frac{2 + 70 + 36 + 40 + 2}{5} = 30$
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Sum of differences from mean			$28 + 40 + 6 + 10 + 28 = 112$
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Index			$\frac{112}{5} = 22.4$
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SECTION B – Question 5 – continued

- b. Calculate the index for each of lagoons A and B.

4 marks

Index for lagoon A =

Index for lagoon B =

- c. Which of the lagoons has the greatest biodiversity? Give a reason for your answer.

2 marks

- d. Name the international treaty that is most relevant to this situation and give a reason why it is relevant.

3 marks

SECTION B – continued
TURN OVER

Question 6 (9 marks)

A crushed-rock quarry is on a site of 65 hectares. The quarry generates \$2.2 million in profit each year. It employs 57 workers at the quarry and 25 others in support industries. The quarry has been operating for 33 years and the rock material is predicted to last another 20 years. The pit itself is 210 metres deep and occupies 35 hectares of the site.

The quarry company has proposed a westerly extension to the pit of 13 hectares to allow the quarry to operate well into the future. The land to the west contains a remnant woodland ecosystem and a small wetland that is a habitat for native fish and frogs.

An alternative proposal has been suggested to stop the extension, close the quarry and turn the entire site into parkland. This would involve removing the mining infrastructure, revegetating the site with native plants, and constructing walking trails, playgrounds and visitor facilities. The pit itself would be converted into a lake. The proposal also includes building 110 low-cost community housing units on three hectares of the site at a cost of \$3.9 million and employing 115 construction workers for three years.

This alternative proposal has been developed partly due to concerns about the lack of recreational facilities in the region as well as complaints from the local community about noise, potentially toxic dust, waste piles and other effects from the quarry. The local community is also worried about loss of water quality in the wetland and creek if the extension is allowed to proceed. Those in favour of closing the quarry argue that the company should move its operation 35 kilometres south of the current site, to a new site with an extensive reserve of suitable rock and few residents.

- a. Identify points that would be used as major arguments in the decision-making process. Summarise these arguments in the table below.

3 marks

	Quarry proposal	Parkland proposal
Social factors		
Economic factors		
Environmental factors		

SECTION B – Question 6 – continued

- b.** Data must be collected in preparation for the decision-making process.

Give **two** examples of data collection that should be carried out when preparing for the decision-making process.

2 marks

- c.** Considering both sides of the issue, make a recommendation as to which proposal should be allowed to proceed (you may also recommend neither proposal). Justify your recommendation.

4 marks

END OF QUESTION AND ANSWER BOOK

