VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2016

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER | | | | | | | | | Letter |

ENVIRONMENTAL SCIENCE

Written examination

Friday 11 November 2016

Reading time: 11.45 am to 12.00 noon (15 minutes)
Writing time: 12.00 noon to 2.00 pm (2 hours)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
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 correction fluid/tape.

Materials supplied
- Question and answer book of 28 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 classified as a renewable energy source?

A. oil
B. nuclear
C. natural gas
D. hydro-electricity

Question 2

Dams collecting water in the Snowy Mountains are an important source of hydro-electricity in Australia. The water that is stored in these dams is released to create electricity.

This is

A. 100% energy efficient.
B. converting potential energy into kinetic energy.
C. converting chemical energy into electrical energy.
D. converting electrical energy into mechanical energy.

Question 3

The owners of a large pig farm have built a system to collect the animal waste, process this waste and collect the methane gas produced. The methane gas is then burnt to generate heating for the farm buildings.

This system would be classified as using a

A. biomass energy source.
B. fossil fuel energy source.
C. natural gas energy source.
D. non-renewable energy source.

Question 4

The combustion of methane gas would be classified as an exothermic reaction because

A. heat is being given off.
B. the process is highly energy efficient.
C. the energy is being converted from one form to another.
D. waste material is being used in an ecologically sustainable manner.

DO NOT WRITE IN THIS AREA

Question 5

A company makes front-loading washing machines. These machines are both more energy efficient and more efficient in terms of water usage than the company's top-loading machines.

This is environmentally important because

A. consumers save money on both their electricity and water bills.

B. energy-efficient washing machines reduce the need to produce electricity.

C. machines that use less energy and water are able to clean clothes more effectively.

D. energy-efficient washing machines have a shorter life span than less efficient washing machines.

Question 6

Washing machines are approximately 30% more energy efficient than they were 25 years ago. Twenty-five years ago, the average washing machine used 650 kWh per year.

What is the approximate energy saving per year, in kilowatt hours, of a new washing machine?

A. 163

B. 195

C. 216

D. 455

Question 7

What are the two main gases that contribute to the natural greenhouse effect?

A. methane and ozone

B. carbon dioxide and methane

C. carbon dioxide and water vapour

D. sulfur dioxide and carbon dioxide

Question 8

What are the two main gases produced by human activity that enhance the greenhouse effect?

A. carbon dioxide and ozone

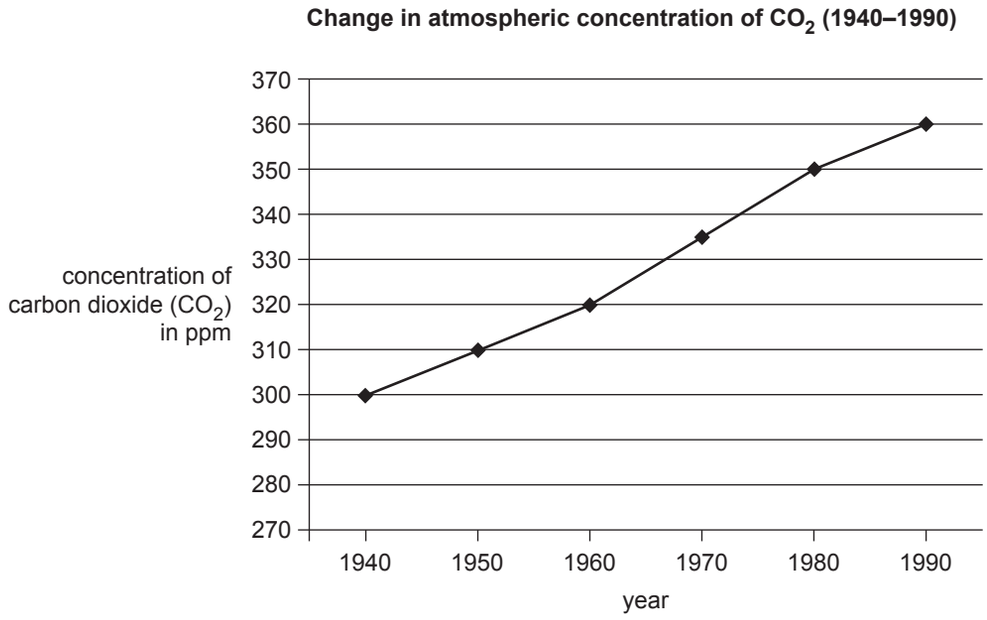
B. methane and carbon dioxide

C. carbon dioxide and water vapour

D. carbon dioxide and sulfur dioxide

Use the following information to answer Questions 9 and 10.

The graph below shows the concentration of carbon dioxide in the lower Earth atmosphere from 1940 to 1990.



Question 9

The percentage increase in the concentration of carbon dioxide in the lower atmosphere between 1940 and 1990 is closest to

A. 17%

B. 20%

C. 60%

D. 120%

Question 10

A major consequence of this increase in concentration of carbon dioxide is

A. an increased amount of ultraviolet energy reaching Earth's surface.

B. a decreased amount of visible light energy reaching Earth's surface from the sun.

C. an increased amount of re-radiated visible light energy being absorbed in the lower atmosphere.

D. an increased amount of re-radiated infra-red energy being absorbed in the lower atmosphere.

Question 11

The average temperature of Earth's surface is largely determined by the

A. balance between incoming and outgoing infra-red energy.

B. excess of incoming infra-red energy over outgoing visible light energy.

C. balance between incoming ultraviolet energy and outgoing infra-red energy.

D. balance between incoming visible light energy and outgoing infra-red energy.

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Question 12

Australia's 2011 State of the Environment report declares, 'Research into the health effects of particles and ozone, along with pollutants such as sulfur dioxide, indicates that there is no threshold level below which they have no health effect'.

This statement means that

A. there is a safe minimum level for these pollutants.

B. even low concentrations of these pollutants can affect people's health.

C. high concentrations of these pollutants are hazardous.

D. some people can tolerate large exposure to these pollutants.

Question 13

Emission of mercury and its compounds into Australian creeks, rivers and lakes in 2001 was 127 kg and in 2004 it was 92 kg.

The percentage change in emissions from 2001 to 2004 was

A. –38%

B. –28%

C. 38%

D. 62%

Question 14

Which of the following is a significant source of airborne mercury pollution in Australia?

A. aluminium smelting

B. hydro-electric power stations

C. natural rock ores in the ground

D. sediment at the bottom of lakes and the ocean

Question 15

The main reason that scientists monitor emissions of mercury and its compounds is that these substances are

A. toxic.

B. acute.

C. chemicals.

D. valuable.

Question 16

Mercury bioaccumulates through aquatic food chains.

Which one of the following represents evidence of mercury bioaccumulation?

A. extensive poisoning of fish in an ecosystem

B. the total mass of fish in an ecosystem increasing as the mercury emissions increase

C. the total mass of mercury in fish in a lake being less than the mass of mercury in the plants in the lake

D. predatory fish containing 5 mg of mercury per kilogram of body weight, with the fish they eat containing 1 mg of mercury per kilogram of body weight

Question 17

Major natural transport mechanisms for mercury or its compounds are

A. roads, rivers, lakes and wind.

B. wind, rain, lightning and rivers.

C. sea, waves, plant growth and salt.

D. rivers, wind, rain and water movement through soil.

Question 18

Rats can eat large amounts of cryolite once with little or no harmful effects. However, rats that eat small amounts of cryolite every day become ill and die.

Which type of toxicity is cryolite causing in this example?

A. acute

B. chronic

C. persistent

D. synergistic

Question 19

Which one of the following is a diffuse source of pollution?

A. a pipe

B. a city

C. a ship

D. a chimney

Question 20

An animal population is more likely to suffer the damaging effects of inbreeding when

A. genetic drift is high.

B. genetic diversity is low.

C. genetic swamping has occurred.

D. genetically different individuals mate.

Use the following information to answer Questions 21–23.

Pachypodium is a genus of spine-bearing trees and shrubs that is native to Madagascar and Africa. All species of *Pachypodium* are protected under the Convention on International Trade in Endangered Species (CITES). Many species are grown in specialised nurseries for sale to collectors of rare plants. Some of these nurseries use the Monk Skipper Butterfly to move between *Pachypodium* flowers in order to imitate the natural reproductive mechanism of the trees in their native habitat.

Question 21

The main objective of CITES is to

A. protect endangered animals and plants.

B. ban the importation of non-native species.

C. ensure a fair price is paid when trading endangered species.

D. support the monitoring of endangered plants and animals in their habitat.

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Question 22

The Monk Skipper Butterfly is

A. a pollinator of species of *Pachypodium*.

B. a predator of species of *Pachypodium*.

C. damaging the *Pachypodium* flowers by feeding on them.

D. contributing to genetic swamping of species of *Pachypodium*.

Question 23

The reproduction of species of *Pachypodium* in nurseries

A. stops the purchase of these species by collectors.

B. lowers species diversity in the natural habitat.

C. reduces the chance of extinction of the species.

D. causes a reduction in population size in the wild.

Question 24

An environmental management plan was put in place during the construction of a tourist resort. The plan included maintenance of native grasslands. These grasslands are found in the middle of the development and link surrounding habitats.

These grasslands are best described as

A. regulatory frameworks.

B. remnant vegetation providing a wildlife corridor.

C. human intervention reducing ecosystem diversity.

D. habitat modification causing loss of endangered species.

Question 25

A small population of the marsupial Kakadu Dunnart was found in Kakadu National Park in 1980 and remains the only identified population in the world.

The Kakadu Dunnart is

A. an exotic species.

B. non-native to Australia.

C. endemic to the Kakadu region.

D. found in an urban environment.

Question 26

Coral reefs play a vital role in tropical waters around the planet. They are important breeding grounds for fish and other marine species. They also protect coastlines from storm erosion and remove carbon dioxide from the atmosphere.

These actions would best be described as

A. social benefits.

B. ecosystem services.

C. biodiversity resources.

D. transport mechanisms.

Question 27

The African Dwarf Crocodile is a species found in swamps and rainforest rivers in western Africa. The crocodile has been hunted as a food source and continual deforestation is causing a loss of its habitat. If these threatening processes continue, the species is thought to be at a high risk of extinction in the medium-term future.

Which one of the following conservation categories would best be used to classify the species at present?

A. extinct

B. vulnerable

C. critical

D. endangered

Question 28

Five different threatened species exist only in one location – a very large, undisturbed, forest habitat.

The most effective method of conserving these species would be to

A. protect the forest habitat through legislation by creating a national park.

B. monitor these species using a variety of scientific data collection techniques.

C. capture three or four individuals from each of these species and set up captive breeding programs in a zoo.

D. list all five of the threatened species under CITES.

Use the following information to answer Questions 29 and 30.

An evaluation of a former factory site by the Environment Protection Authority has identified soil that is contaminated with heavy metals on part of the site and a number of other environmental concerns regarding water quality.

Question 29

This evaluation would be regarded as

A. a life-cycle assessment.

B. a bioremediation project.

C. an environmental risk assessment.

D. an ecologically sustainable development.

Question 30

The Environment Protection Authority outlines a number of guidelines regarding the removal of toxic soil and protection of groundwater. These guidelines must be followed in order for the development of the former factory site to be legally allowed to proceed.

These guidelines would be regarded as

A. part of the regulatory framework for environmental projects.

B. part of the precautionary principle that needs to be followed.

C. a way of including all relevant stakeholders in the environmental management process.

D. something that government departments should do to remind people of the importance of environmental health and safety.

END OF SECTION A

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SECTION B

Instructions for Section B

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

Question 1 (16 marks)

A large-scale wind farm has recently been developed near a region of around 105 000 people. The 120 wind turbines on the farm supply the region with 190 MW of electricity, which is approximately 15% of the region's electricity requirements. In the past, the region has been reliant on a fossil fuel power station for its electricity supply.

Nominate a fossil fuel and a non-fossil fuel energy source that you have studied.

Fossil fuel energy source _____

Non-fossil fuel energy source _____

a. One reason for the construction of the wind farm was the regional government's concern about the impact of fossil fuel extraction.

Describe **two** environmental impacts that can result from the extraction of your nominated fossil fuel. 2 marks

_____

_____

_____

_____

b. Identify the key steps in the process of energy conversion from the source of your nominated fossil fuel to the supply of electricity in the region. 3 marks

_____

_____

_____

_____

_____

_____

DO NOT WRITE IN THIS AREA

c. Emissions trading has been suggested as an option for reducing the amount of greenhouse gases being emitted.

Explain the key steps of an emissions trading system that could be used to encourage a reduction in emissions from the fossil fuel power station. 4 marks

d. There are plans for the region to increase its supply of non-fossil energy from 15% to 75% of the total electricity requirements.

Explain **two** benefits of this proposal. 3 marks

e. **i.** Describe the challenges that peak and off-peak energy demands create for your nominated non-fossil energy source. 2 marks

ii. Explain how **one** of the challenges described in **part e.i.** could be overcome to allow for the consistent generation of electricity needs by your nominated non-fossil energy source. 2 marks

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Question 2 (12 marks)

Figure 1 shows Earth, the sun and parts of Earth's atmosphere.

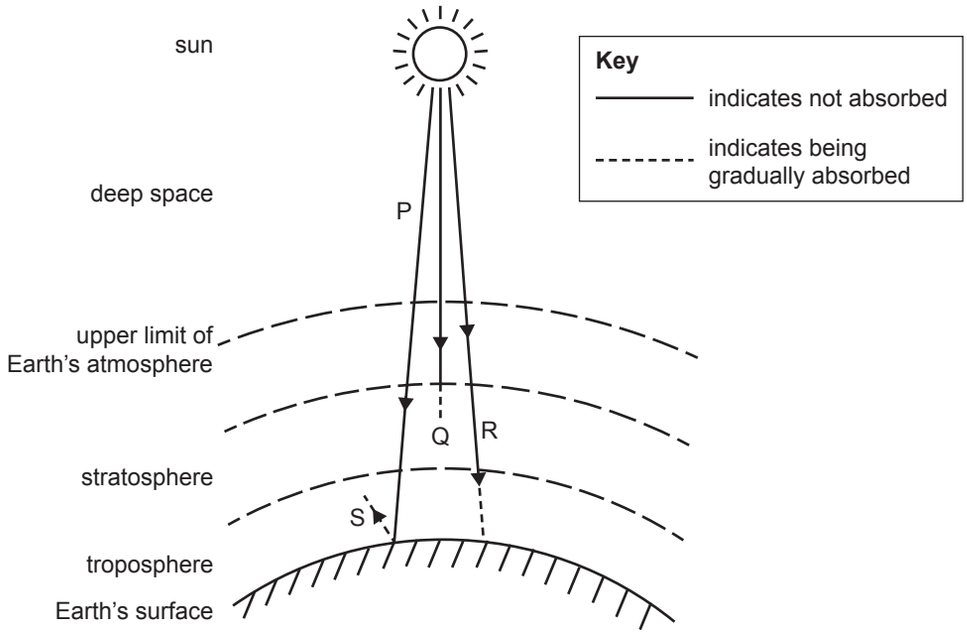

Figure 1

a. In the table below, indicate which type of radiation – 'infra-red', 'visible' or 'ultraviolet' – best fits each of the lines P, Q, R and S. 4 marks

Line	Radiation type
P	
Q	
R	
S	

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b. Outline the difference between the natural and enhanced greenhouse effects. For each type of greenhouse effect, include its major cause and the consequence for humans. 4 marks

Nominate a fossil fuel energy source that you have studied.

c. Describe a process of using your nominated fossil fuel energy source and how this has an impact on the enhanced greenhouse effect. 2 marks

d. Outline a strategy that will allow for the continued use of your nominated fossil fuel energy source but still reduce its environmental impact. 2 marks

Question 3 (17 marks)

A large ore smelter processes lead, zinc and copper ores. People living near the smelter's large chimney. The government decides to establish an air quality monitoring station.

The national standard for sulfur dioxide emissions is a maximum concentration of 200 parts per billion averaged over an hour.

The following table lists hourly sulfur dioxide emission concentrations measured at the monitoring station on a day when the smelter operated at a constant rate from 6 am to 3 pm. The smelter shuts down at 3 pm.

Time	Hourly sulfur dioxide concentration (parts per billion)
6 am	20
7 am	40
8 am	80
9 am	120
10 am	160
11 am	60
12 noon	40
1 pm	100
2 pm	140
3 pm	140
4 pm	40
5 pm	40

a. Describe **one** harmful effect of exposure to sulfur dioxide. 2 marks

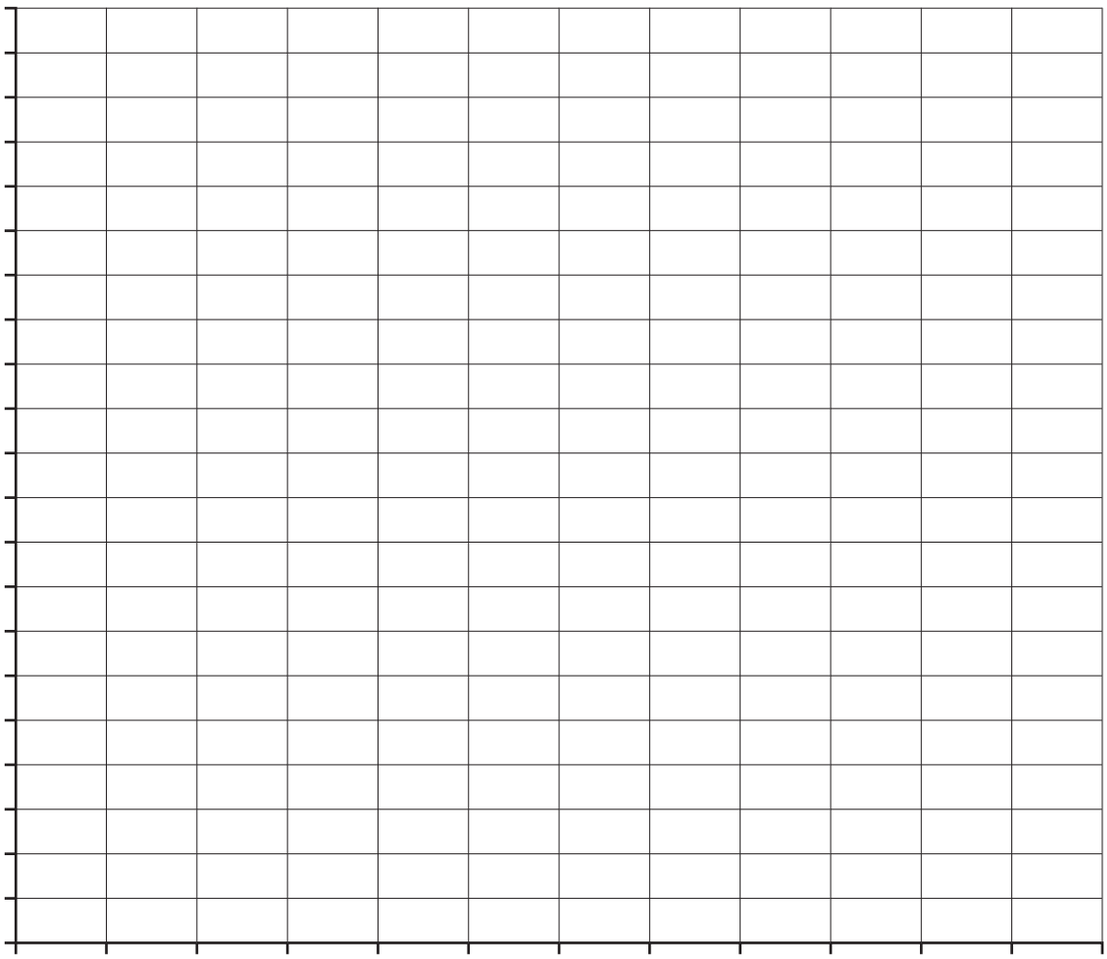
b. Is the smelter a point or diffuse source of pollution? Explain your answer. 2 marks

c. Explain **two** factors that the government would have considered when deciding where to place the monitoring station. 3 marks

d. **i.** Draw a graph of hourly sulfur dioxide concentration (on the vertical axis) versus time of day (on the horizontal axis) on the grid provided below. Include a suitable title, label the axes and include suitable scales. 4 marks

ii. Add to the graph a labelled line showing the national standard for the one-hour sulfur dioxide average. 1 mark

Title _____



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e. Explain **two** reasons for the drop in monitored sulfur dioxide concentrations from 10 am to 12 noon. 3 marks

f. Explain why the monitored sulfur dioxide concentrations never reach zero, even when the smelter is not operating. 2 marks

Question 4 (14 marks)

The giant clam (*Tridacna gigas*) is a large sessile (attached to the ground) shellfish found in coral reef habitats, including the Great Barrier Reef of Australia. Visitors to the area admire the striking blue colour and impressive size of the clams, which can grow up to 1.2 m and weigh up to 200 kg.

During reproduction, each giant clam releases eggs and sperm into the water, which are carried in the current to be fertilised. Young clams undergo a growth stage in open water before settling and attaching to sand or coral rubble. The excess eggs can be consumed by fish that are considered to be 'opportunistic feeders'.

The giant clam feeds by allowing a large variety of animal and plant matter to float into its large 'mouth' opening. In this way, the clam acts as a water filter. The clam also gains a dependable source of food from the waste products of a symbiont algae species that lives on the clam's internal tissues. The algae are photosynthetic, requiring light to grow.

The giant clam is listed as vulnerable by the International Union for Conservation of Nature and overexploitation by humans has caused its probable extinction in several countries. There has also been a reduction in diversity and abundance of other species in the coral reefs that are home to the clam.

a. Explain why the algae can be termed a 'symbiont' of the giant clam. 2 marks

b. Describe **two** human activities that could be a threat to the giant clam and explain how each would have an impact on the species. 4 marks

DO NOT WRITE IN THIS AREA

c. Explain how a reduction in diversity and/or abundance of other species might have a negative impact on the giant clam. 2 marks

d. An extensive and diverse coral reef has recently been identified near Wilsons Promontory Marine Park and underwater cameras are being used to search for signs of endangered species in this area.

If the giant clam were to be found here, outline why it should be included on the threatened list of the *Flora and Fauna Guarantee Act 1988*. 2 marks

e. Describe **two** management actions that might be detailed in the *Flora and Fauna Guarantee Act 1988* Action Statement for the giant clam. 4 marks

Question 5 (15 marks)

A scientist, Sophie, conducts a scientific survey of different species of glider possums in the Central Highlands of Victoria. She samples three random areas of equal size and her findings are shown in the table below.

Species	Conservation status	Area X	Area Y	Area Z
Sugar Glider	not threatened	30	60	10
Feather-tail Glider	not threatened	20	20	10
Greater Glider	endangered	10	0	0
Yellow-bellied Glider	vulnerable	20	20	5
Squirrel Glider	vulnerable	20	0	5

a. In which of the three areas, X, Y or Z, was the lowest species richness observed? Explain your answer, making clear the meaning of the term 'species richness'. 3 marks

DO NOT WRITE IN THIS AREA

b. Another scientist, Thanh, looks at Sophie's data. He states that Area Z has the least biodiversity as it has the least number of individuals.

Is Thanh's view of biodiversity correct? Explain your answer. 3 marks

c. Explain why Sophie chose to sample three random areas that were of equal size. 2 marks

Sophie uses Simpson's Index of species diversity (biodiversity), D, to evaluate the three areas. Simpson's Index is defined as follows.

$D = 1 - (p_1^2 + p_2^2 + p_3^2 + \ldots + p_n^2)$, where there are different species in the area

where $p_1 = \dfrac{\text{number of individuals of Species 1 in an area}}{\text{total number of individuals in area}}$

The higher the value of D, the greater the biodiversity (species diversity).

The calculation for Area X is shown below.

Species	**Number of individuals of this species**	$p = \dfrac{\textbf{number of individuals of this species}}{\textbf{total number of individuals in area}}$	p^2
Sugar Glider	30	$p = 30/100 = 0.30$	0.09
Feather-tail Glider	20	$p = 20/100 = 0.20$	0.04
Greater Glider	10	$p = 10/100 = 0.10$	0.01
Yellow-bellied Glider	20	$p = 20/100 = 0.20$	0.04
Squirrel Glider	20	$p = 20/100 = 0.20$	0.04

total number of individuals = 100 sum of $p^2 = 0.09 + 0.04 + 0.01 + 0.04 + 0.04 = 0.22$

Simpson's Index for Area X = 1 – sum of $p^2 = 1 - 0.22 = 0.78$

Sophie also calculates D for Area Z and $D = 0.72$

d. Use the table below to calculate Simpson's Index for Area Y. 3 marks

Species	**Number of individuals of this species**	$p = \dfrac{\textbf{number of individuals of this species}}{\textbf{total number of individuals in area}}$	p^2
Sugar Glider	60		
Feather-tail Glider	20		
Greater Glider	0		
Yellow-bellied Glider	20		
Squirrel Glider	0		

total number of individuals = ☐ sum of p^2 = ☐

Simpson's Index = 1 – sum of p^2 = ☐

DO NOT WRITE IN THIS AREA

e. Which area has the greatest species diversity? Explain your answer, making clear the meaning of the term 'species diversity'. 3 marks

f. Scientists use three conservation categories to classify the degree of risk to threatened species.

List these categories in order of highest risk of extinction to lowest. 1 mark

Highest risk _____

Middle risk _____

Lowest risk _____

Question 6 (16 marks)

A proposal has been developed to construct a bridge from a rapidly growing coastal town on the mainland to a nearby island. Currently, the only link to the mainland is a small ferryboat that runs twice a week. Most of the island is untouched bushland.

The coastal region is already popular with tourists and developers want to build more houses on the island. The building of the bridge would allow a number of housing developments to go ahead.

The intention is for all buildings to use renewable energy forms for all their energy requirements, be largely built of recycled materials and be highly energy efficient, both during construction and operation. All buildings will include appliances with five-star energy ratings, light-emitting diode (LED) lighting and solar water-heating systems.

The island has a permanent population of 350 people, but if the housing developments go ahead, the number of permanent residents will rise to around 5000. This number will increase by an extra 2000 over the summer holiday period.

The southern end of the island includes a large salt marsh and tidal flats area that is a habitat for a large seabird colony with over 25 different species, including some migratory species. The importance of this coastal site has meant that it is declared under the Ramsar Convention. At present, the island has no feral animals such as foxes, cats, rats or rabbits. A nearby island with similar environmental characteristics was studied by scientists before and after being invaded by rabbits and rats. The study showed a significant decrease in the native wildlife, especially reptiles, small mammals and seabirds.

The 'Friends of the Island' environmental group has joined with the local recreational fishing group to oppose the plan. They have concerns about the impact of building the bridge on fishing grounds, about the increasing population numbers having an impact on the island's habitat and about the possible disposal of treated sewage into the marine environment. The environmental group has collected over 1000 signatures on a petition against the bridge and housing developments, and plans to hold a number of protest meetings.

a. The housing developers argue that the plans to make the island totally reliant on renewable energy forms and build energy-efficient housing would mean that the whole bridge and housing development should be regarded as an ecologically sustainable development.

Evaluate this claim using **two** principles of ecologically sustainable development. 4 marks

DO NOT WRITE IN THIS AREA

b. Explain why the southern end of the island has been declared a protected site under the Ramsar Convention. 2 marks

c. Under the Ramsar Convention, any action that will have, or is likely to have, a significant impact on the ecological character of a designated Ramsar site must be referred to the Federal Minister for the Environment. In this case, the minister determines that an environmental impact assessment needs to be prepared.

Describe **two** steps in the environmental impact assessment process that should be followed. 3 marks

d. What role should the local environmental group and the existing residents of the island play in the environmental impact assessment process? 2 marks

e. Describe key arguments for and against the planned development of the island. Using these points, clearly make a recommendation about whether the bridge and housing developments should be allowed to proceed. 5 marks

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END OF QUESTION AND ANSWER BOOK