

STUDENT NUMBER Letter

ENVIRONMENTAL SCIENCE

Written examination

Monday 10 November 2014

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

| <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 24 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 can be described as a non-renewable, non-fossil fuel energy source?

- A. oil
- B. biomass
- C. uranium
- D. natural gas

Use the following information to answer Questions 2–7.

Emily lives on a farm. She has two options for a source of electricity: connecting to a nearby hydro-electric power plant or using solar panels. She decides to use solar panels. The power received from the sun is an average of 0.5 kW per square metre when the sun is shining. She places 10 solar panels on her roof. Each panel is 1.0 m².

Question 2

Which one of the following best indicates the power into the solar panel system when the sun is shining?

- A. 0.5 kW
- B. 1.0 kW
- C. 5.0 kW
- D. 50 kW

Question 3

On a cloudy day, the total input to the solar panel system from the sun is 0.75 kW.

Emily measures the output from the system as 0.15 kW.

Which one of the following best gives the percentage efficiency of the system?

- A. 15%
- B. 20%
- C. 50%
- D. 75%

Question 4

The solar panel system provides too little power for Emily's needs, so she connects to the newly constructed local hydro-electric power plant, based on a large dam nearby.

Which one of the following describes the overall energy conversion involved in a hydro-electric power plant?

- A. heat energy to electrical energy
- B. electrical energy to kinetic energy
- C. chemical energy to electrical energy
- D. gravitational potential energy to electrical energy

Question 5

Roger claims that the hydro-electric power plant is not as environmentally friendly with respect to global warming as the solar panels.

One major reason for this claim is that

- A. the heat from the generators warms the atmosphere.
- B. carbon dioxide evaporates from the water in the dam.
- C. the hydro-electric power plant emits large quantities of a greenhouse gas.
- D. the removal of trees to construct the dam results in fewer carbon dioxide sinks.

Question 6

Which one of the following best describes a hydro-electric power plant?

- A. a renewable fossil energy source
- B. a non-renewable fossil energy source
- C. a renewable non-fossil energy source
- D. a non-renewable non-fossil energy source

Question 7

Roger maintains that the hydro-electric power plant is an ecologically sustainable development.

A valid reason for this view is that

- A. it is more efficient than a coal-fired power plant.
- B. the water cools the local atmosphere, hence reducing global warming.
- C. it provides a body of water for the local fish, birds and other aquatic animals.
- D. it does not consume an energy resource, leaving this resource available for future generations.

DO NOT WRITE IN THIS AREA

Use the following information to answer Questions 8–13.

Frog Species A and B are endemic to the Queensland hinterland, but only small populations of each species still survive in this area. Habitat destruction and the cane toad (an exotic species) are the main threats to both species. An ecologist estimates the probability of extinction in the next 20 years to be **0.90** for Species A and **0.40** for Species B.

Question 8

The probability of both species becoming extinct within the next 20 years is

- A. 0.36
- B. 0.50
- C. 0.65
- D. 1.30

Question 9

Which of the following is the most likely classification given to each species?

| | Species A | Species B |
|----|-----------------------|---------------------|
| A. | vulnerable | endangered |
| B. | extinct in the wild | endangered |
| C. | critically endangered | vulnerable |
| D. | critically endangered | extinct in the wild |

Question 10

A small, isolated population of Species B was found to be declining in the total number of individuals.

This population

- A. is at risk of inbreeding.
- B. is more resistant to demographic variation.
- C. has a high number of individual differences.
- D. should not be monitored by conservationists.

Question 11

A small population of Species A experienced random changes in genetic make-up over several generations.

This is an example of

- A. gene flow.
- B. genetic drift.
- C. high genetic diversity.
- D. a successful management strategy.

Question 12

The best management plan for a small population of Species A would include

- A. hand-feeding by park rangers.
- B. capture and release into a warmer habitat.
- C. placement of two individuals of the species in a zoo.
- D. actions to stop or reverse the effects of habitat destruction and exotic species.

Question 13

The relationship between frog Species A and the cane toad is an example of

- A. symbiosis.
- B. competition.
- C. host-parasitism.
- D. cross-pollination.

Use the following information to answer Questions 14 and 15.

A company has applied to the relevant Australian government agency for a permit to import a variety of stuffed wild animals for sale to private collectors. A number of these specimens are listed as endangered in their native country.

Question 14

Because Australia is a signatory to CITES, the company is denied permission.

CITES is an abbreviation for the

- A. Convention on the Illegal Trade of Endangered Species.
- B. Convention on International Trade of Endangered Species.
- C. Cooperation for the International Treatment of Endangered Species.
- D. Convention against the Inhumane Treatment of Endangered Species.

Question 15

Under CITES guidelines, the application was not permitted because

- A. there were concerns about diseases being introduced into Australia.
- B. it is illegal to trade any animal or plant materials that are listed in the guidelines.
- C. the imported stuffed wild animals may be in competition with locally produced ones.
- D. no country is to allow the import or export of live animals or animal products from any endangered species.

DO NOT WRITE IN THIS AREA

Use the following information to answer Questions 16 and 17.

A manufacturer conducted an investigation into the types of light globes it produces. The aim of the manufacturer was to find better sources of raw materials to improve the energy efficiency of its products and the manufacturing processes used to make them. The manufacturer found that light-emitting diodes (LEDs) are simpler to produce, have a much longer life span than normal light globes and release fewer pollutants when they are disposed of. LEDs are five times more efficient than normal light globes, which would lead to energy savings and reduced carbon dioxide emissions.

Question 16

The light-globe manufacturer's investigation would best be described as

- A. a Life Cycle Assessment.
- B. a waste minimisation study.
- C. an Environmental Risk Assessment.
- D. an Environmental Management Plan.

Question 17

LEDs are more energy efficient than normal light globes because they

- A. cost much less to manufacture.
- B. operate at a higher temperature.
- C. produce less waste heat when operating.
- D. contribute a much lower level of greenhouse gas to the atmosphere.

Question 18

The key aim of an Environmental Risk Assessment is to

- A. determine some of the possible human health risks of an environmental project.
- B. continually assess and monitor environmental problems associated with an environmental project.
- C. create an objective analysis and comparison of the relative risks of a particular activity to an ecosystem.
- D. assess and quantify key factors that would be of benefit to the environment if a particular project were developed.

Question 19

Waste from a factory has been illegally dumped in a wetland, leading to some pollutants entering the body of water.

Bioremediation of the wetland would focus on

- A. using plants and bacterial activity to remove pollutants over time.
- B. cleaning up the pollutants by using manual and chemical methods.
- C. ensuring that threatened waterbird species are not harmed by the polluted waters.
- D. fining the owners of the factory under regulatory frameworks managed by the Environment Protection Authority.

Question 20

A pollutant can best be described as a

- A. harmful solid, liquid or gas.
- B. waste product created by human activity.
- C. toxic substance controlled by government legislation.
- D. substance introduced into the environment with undesired effects.

Question 21

Smokers who are exposed to asbestos have a greater chance of contracting a lung disease than smokers who are not exposed to asbestos.

This is an example of

- A. synergistic action.
- B. pollutant mobility.
- C. dual-point sources.
- D. the specificity of environmental hazards.

Question 22

Single exposure to high levels of lead compounds can lead to muscle pains, headaches, nausea and seizures.

These symptoms are due to

- A. lead mobility.
- B. dilution of lead.
- C. chronic lead poisoning.
- D. acute lead poisoning.

Question 23

Laboratory tests show that 50% of rats exposed to 3 g of dichlorodiphenyltrichloroethane (DDT) per kilogram of body weight will die.

What mass of DDT will kill half of the rats in a population of 100, weighing 500 g each?

- A. 3 g
- B. 50 g
- C. 100 g
- D. 150 g

Question 24

Hay fever, asthma, eczema and hives are all consequences of

- A. toxicity.
- B. allergies.
- C. nutrient exposure.
- D. environmental health measures.

DO NOT WRITE IN THIS AREA

Use the following information to answer Questions 25 and 26.

The term 'soil half-life' refers to the time needed for half of the mass of a pollutant to break down in the environment. The table below shows the soil half-lives of various pollutants.

| Pollutant | Soil half-life (months) |
|--------------------|-------------------------|
| aldrin | 10 |
| chlordane | 26 |
| DDT | 36 |
| dieldrin | 22 |
| oxyfluorfen | 16 |
| tetrachlorobenzene | 4 |

Question 25

Of the pollutants listed, DDT has the greatest

- A. toxicity.
- B. specificity.
- C. persistence.
- D. bioaccumulation.

Question 26

The soil in a paddock contains 4 kg of tetrachlorobenzene.

If no additional tetrachlorobenzene is added to the soil, how many months will it take before there is just 1 kg of tetrachlorobenzene remaining in the paddock?

- A. 8
- B. 12
- C. 16
- D. 20

Question 27

Microbes in soil help decompose pollutants in soil.

The microbes within the soil behave as a

- A. sink.
- B. diffuse source.
- C. bioaccumulator.
- D. synergistic actor.

Question 28

Which one of the following represents a significant source of sulfur dioxide as an airborne pollutant within Australia?

- A. rooftop solar panels
- B. fertiliser application
- C. mineral ore processing
- D. hydro-electric power plants

Question 29

The use of which one of the following would be the most effective way of reducing emissions of sulfur dioxide from a chimney?

- A. large fans
- B. water spray
- C. paper filters
- D. magnetic plates

Question 30

Which one of the following is **not** a property of sulfur dioxide?

- A. It is a gas that is less dense than air.
- B. It is able to form acid in the environment.
- C. It is produced during the combustion of sulfur-containing substances.
- D. Each of its molecules contains one sulfur atom and two oxygen atoms.

DO NOT WRITE IN THIS AREA

**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 (15 marks)

The residents of a small island, approximately 200 km off the coast of mainland Australia, are planning to improve the island’s electricity supply system. At present, 85% of the electricity supply for the 3000 residents comes from a fossil fuel powered generation plant, with the remaining energy being fed into the grid from non-fossil fuel energy sources. There are no sources of fossil fuel on or around the island. The plan is to increase non-fossil fuel sources to provide up to 60% of the island’s electricity needs, including developing a large-scale battery storage system that can provide electricity at appropriate times during the day. Apart from domestic use, electricity is being used by a growing tourism industry.

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

Fossil fuel energy source _____

Non-fossil fuel energy source _____

- a. How can this fossil fuel energy source be used to generate electricity for the island? What infrastructure would be required to achieve this? 2 marks

- b.
 - i. Outline the forms of energy and conversion steps that would be required to generate electricity from this fossil fuel. 3 marks

DO NOT WRITE IN THIS AREA

ii. Suggest why this energy conversion process is not 100% efficient.

2 marks

c. In relation to accessibility, distribution and efficiency, why may the residents on the island consider moving towards greater input from non-fossil fuel energy sources?

3 marks

d. Describe **one** positive and **one** negative potential environmental impact of increasing the use of your non-fossil fuel energy source on the island.

3 marks

e. Why would a battery storage system need to be developed to allow for the increased use of non-fossil fuel energy sources?

2 marks

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 2 (12 marks)

Figure 1 shows radiation entering Earth's atmosphere.

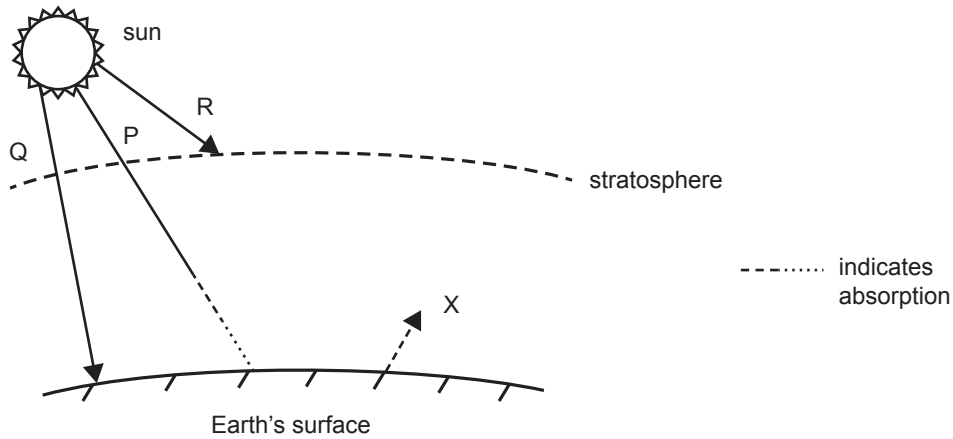


Figure 1
not to scale

- a. Which one of the following (A.–D.) best describes the types of incoming radiation? Write your answer in the box.

1 mark

| | Infrared | Visible | Ultraviolet |
|----|----------|---------|-------------|
| A. | P | Q | R |
| B. | Q | R | P |
| C. | Q | P | R |
| D. | R | P | Q |

- b. Referring to X in Figure 1, identify the type of radiation, describe how it originates and explain the mechanism by which it contributes to the natural greenhouse effect.

4 marks

- c. Name the gas that is the largest contributor to the natural greenhouse effect. 1 mark

- d. Explain why the natural greenhouse effect is important. 2 marks

- e. Name one gas produced by human activity that is contributing to the enhanced greenhouse effect. Describe a major source of this gas and state **two** methods of reducing atmospheric concentrations of this gas. 4 marks

Gas _____

Source _____

Methods of reducing gas _____

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 3 (16 marks)

a. State **three** key properties of mercury. 3 marks

b. Describe the major human health effects of excessive exposure to mercury and its compounds. 2 marks

c. Briefly describe **two** human-created sources of mercury. 2 marks

d. Select **one** of the human-created sources of mercury you have described in **part c.** and explain whether it is a point or diffuse source. 2 marks

DO NOT WRITE IN THIS AREA

- e. Mercury can be transported in the environment by air and water.

Describe these two transport mechanisms of mercury, including the chemical form in which it is carried.

4 marks

- Transport mechanism – air

Description _____

- Transport mechanism – water

Description _____

- f. Describe the process of chemical change that occurs to elemental mercury, which enables it to accumulate in the tissues of fish and shellfish.

3 marks

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 4 (15 marks)

The Green Carpenter Bee is a large Australian native bee with a length of 2 cm and a distinctive blue-green body. Scattered populations of the bee can be found along the east coast of Australia, as well as on Kangaroo Island in South Australia. The bee nests in the dry grass and dead branches of some Australian native tree species.

Bushfires on Kangaroo Island in 2007 drastically reduced the habitat suitable for the Green Carpenter Bee to only a few areas of surviving vegetation. The Green Carpenter Bee now faces extinction on Kangaroo Island, with perhaps only a few small isolated populations remaining. Wildlife officers and visitors to Kangaroo Island are monitoring the population of Green Carpenter Bees by reporting individual sightings. This information will be analysed and a recovery management plan will be developed.

These bees are ‘buzz pollinators’. They remove pollen from the Australian native guinea flower by vibrating the flower until pollen falls out. Other common bees, such as the honey bee, are unable to remove pollen from the guinea flower in this way, so the Green Carpenter Bee is an important pollinator of the guinea flower. The guinea flower has also decreased in abundance on Kangaroo Island in recent years, even though it is able to grow relatively quickly from seed following a bushfire.

- a. State the scientific term used to describe the surviving habitat that is still populated by the Green Carpenter Bee on Kangaroo Island. 1 mark

- b. Is the Green Carpenter Bee endemic to Kangaroo Island? Justify your answer. 2 marks

- c. Using the information provided, how might the reduction in the number of Green Carpenter Bees have led to the reduction in abundance of the native guinea flower on Kangaroo Island? 2 marks

DO NOT WRITE IN THIS AREA

- d. The following strategies may be included in the recovery plan for the Green Carpenter Bee on Kangaroo Island.

State one possible advantage and one possible disadvantage for each strategy.

- i. Relocation of a number of Green Carpenter Bees from the east coast of Australia to Kangaroo Island

2 marks

Advantage _____

Disadvantage _____

- ii. Banning of fuel reduction burns within the patches of surviving vegetation

2 marks

Advantage _____

Disadvantage _____

- e. Describe a different management strategy that may be appropriate for inclusion in the recovery plan.

2 marks

DO NOT WRITE IN THIS AREA

- f. During a community meeting on Kangaroo Island, Thomas argues that resources should not be wasted on protecting the Green Carpenter Bee. He states that the nesting sites of the bee are too rare, so the extinction of the bee is inevitable. He also states that the bee cannot be easily located and so will not draw tourists to the area.

Evaluate Thomas’s arguments, stating whether you believe the Green Carpenter Bee should be the subject of conservation measures.

4 marks

DO NOT WRITE IN THIS AREA

Question 5 (13 marks)

Scientists are studying the fish biodiversity of three unconnected lakes: A, B and C.

Each lake is approximately 100 hectares in size. The scientists wish to conduct a survey to determine the number of species and the number of individuals within each species.

- a. Describe an appropriate sampling method that could be used to collect data on fish numbers. 3 marks

The scientists record the following data.

Table 1

| Fish species | Lake A | Lake B | Lake C |
|--------------|--------|--------|--------|
| U | 10 | 0 | 10 |
| V | 30 | 35 | 30 |
| W | 150 | 40 | 30 |
| X | 30 | 45 | 0 |
| Y | 70 | 36 | 90 |
| Z | 10 | 44 | 40 |

- b. Which lake has the greatest species richness? Justify your answer. 2 marks

- c. Using the data in Table 1, which lake has the greatest biodiversity? Justify your answer. 2 marks

DO NOT WRITE IN THIS AREA

In a further analysis, the scientists use an index of biodiversity (**I**) that they have developed. This index is given by

$$\mathbf{I} = \frac{\text{sum of the difference of each species from the mean of the whole lake}}{\text{number of different species in that lake}}$$

A lower index indicates a greater species diversity.

The calculations for Lake A at the time of the original survey are shown in Table 2.

Table 2. Lake A original survey

| Species | No. of individuals | Difference from mean |
|---|--------------------|----------------------|
| U | 10 | 40 |
| V | 30 | 20 |
| W | 150 | 100 |
| X | 30 | 20 |
| Y | 70 | 20 |
| Z | 10 | 40 |
| | | |
| Total | 300 | |
| Mean = total / no. of species | 300 / 6 = 50 | |

sum of differences from mean = 240

$$\mathbf{I} = 240 / 6 = 40$$

Two years later, the scientists repeat the survey for Lake A.

The data for the second survey is shown in Table 3.

Table 3. Lake A second survey

| Species | No. of individuals | Difference from mean |
|---|--------------------|----------------------|
| U | 30 | |
| V | 47 | |
| W | 70 | |
| X | 40 | |
| Y | 60 | |
| Z | 5 | |
| | | |
| Total | | |
| Mean = total / no. of species | | |

sum of differences from mean =

$$\mathbf{I} =$$

- d. Calculate the index for Lake A from the data in the second survey. The right-hand column in Table 3 may be used for calculations.

2 marks

Index (I) calculation for Lake A in second survey

- e. Based on your index calculation, has the species diversity increased or decreased? Justify your answer in terms of the index.

2 marks

- f. Referring to the data in the surveys, explain the change in species diversity over the two years.

2 marks

DO NOT WRITE IN THIS AREA

SECTION B – continued
TURN OVER

Question 6 (19 marks)

Australian fisheries produce over 25 000 tonnes of prawns annually. Around 80% of these prawns are caught in the wild, with the other 20% being produced by aquaculture (i.e. fish farms). Farmed prawns generate around \$75 million a year and provide approximately 1000 direct jobs in this industry. It is argued that prawn farming decreases pressure on stocks of prawns in the wild and reduces the impact on other marine species by limiting bycatch (i.e. unwanted species that are caught and killed in the nets of prawn trawlers).

A proposal to develop a prawn farm has been presented to the local council of a coastal region. Currently, the site is mainly used as grazing land around a natural lagoon. The proposal requires the construction of 10 one-hectare ponds, supported by a system of channels, pumping stations and a processing plant with refrigeration rooms. The lagoon has been degraded over the last 20 years and is not thought to provide a habitat for any threatened species. However, the last environmental assessment of fauna and flora species took place 15 years ago.

Wastewater from the prawn ponds containing excess nutrients will be pumped into the lagoon, which flows out into the sea near a major local surf beach. The council has suggested that the owner of the prawn farm needs to construct a three-hectare settlement pond to allow for the treatment and breakdown of nutrient waste by biological organisms, before the treated water is released into the lagoon. The owner of the prawn farm argues that the settlement pond will be an unnecessary cost and that the settlement pond is not needed.

- a. Using **one** key principle of ecologically sustainable development, explain why the proposed development of the prawn farm could be regarded as sustainable. 3 marks

- b. Using a key principle other than the one used in **part a.**, explain why the proposed development of the prawn farm may not be regarded as an ecologically sustainable development. 3 marks

DO NOT WRITE IN THIS AREA

c. Explain how the precautionary principle could be applied to this situation.

3 marks

d. Before the local council considers supporting the prawn farm development, it wants an environmental impact assessment to be prepared.

What is the purpose of preparing an environmental impact assessment?

3 marks

e. Identify a relevant government organisation that could be involved in encouraging responsible environmental practices by the owner of the prawn farm once it is operating.

How could this organisation be involved in monitoring and/or regulating the prawn farm?

2 marks

DO NOT WRITE IN THIS AREA

