2014 Examination Report

2014 Environmental Science GA 3: Examination

GENERAL COMMENTS

Many students were well prepared for the 2014 Environmental Science examination and there were many good, well-thought-through responses to questions.

Advice to students

- Students should read each question carefully and respond to the specific points in the question. A significant number of responses were very general and irrelevant. Many students highlighted or underlined key points in the question. This is a good way of focusing on what needs to be addressed.
- If a specific number of items is required in a student's response (for example, three properties of mercury in Question 3a.) and more than three are given, only the first three will be assessed. Hence, students should not provide a long list of possible answers in the hope that a few of the items on that list are correct. If no number is required by the question, all answers will be considered. Note that if the plural form is used (for example, 'list some methods'), more than one answer will be expected.

SPECIFIC INFORMATION

This report provides sample answers or an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

The statistics in this report may be subject to rounding errors resulting in a total less than 100 per cent.

Section A – Multiple-choice questions

The table below indicates the percentage of students who chose each option. The correct answer is indicated by shading.

Question	% A	% B	% C	% D	% No answer	Comments
1	3	12	76	9	0	A number of students chose option B – biomass. Biomass is considered renewable.
2	4	1	94	1	0	
3	12	79	5	4	0	% efficiency = $^{output}/_{input} \times 100$ $= 0.15/0.75 \times 100 = 20\%$
4	8	3	4	85	0	
5	5	5	16	73	0	The loss of trees as carbon sinks (option D) was the correct response. Option C was incorrect because hydro-electric power plants do not emit greenhouse gases when operating.
6	4	2	90	4	0	
7	4	1	5	90	0	
8	73	6	13	8	0	The probability of both populations becoming extinct is the product of the two individual probabilities: $0.90 \times 0.40 = 0.36$
9	12	7	80	1	0	Neither is extinct, so options B and D were incorrect. Species A is more at risk than Species B, so option C was the only possible answer.
10	96	4	1	0	0	

2014 Examination Report

Question	% A	% B	% C	% D	% No answer	Comments
11	12	66	21	1	0	Random change is genetic drift. Option C was a common incorrect answer. While it is possible that genetic drift may lead to high genetic diversity, it is unlikely, so option B was correct.
12	1	2	8	90	0	
13	11	83	5	1	0	
14	19	74	4	2	0	
15	3	46	1	49	0	Option B was correct because CITES prohibits trade. Option D was incorrect because the movement of live animals is permitted for zoos and other institutions involved in breeding programs in order to protect endangered species and to provide genetic diversity (for example, the elephant breeding program in which the Melbourne Zoo is involved).
16	66	18	6	9	0	The stem discussed production, energy use during lifetime, and disposal. This is a Life Cycle Assessment – option A. Option B was incorrect because there is no reference in the stem to waste in manufacture.
17	2	1	68	29	0	Energy efficiency relates to the ratio of energy input to light output when operating. As most energy loss is heat, option C was correct.
18	12	18	60	9	0	
19	81	8	5	5	0	
20	16	15	0	68	0	The definition of a pollutant requires that it is introduced into the environment by human activity and with harmful effects. The only response covering these two points was option D. Option A was a common incorrect answer; however, it missed the requirement about being introduced by human action.
21	74	4	11	11	0	
22	1	1	14	84	0	
23	12	19	9	59	1	100 rats @ 500 g each = 100 × 0.500 = 50 kg of rats 3 g per kilogram kill 50% of rats, so you need 50 × 3 g = 150 g
24	9	83	4	4	0	
25	5	1	91	3	0	
26	67	22	9	2	1	The half-life (time for the amount to halve) of tetrachlorobenzene is four months. Start with 4 kg. After four months: ½ of 4 = 2 kg After four more months (eight months): ½ of 2 = 1 kg So option A, eight months, was correct.
27	67	5	13	14	1	A sink removes pollutants from the environment. Microbes are a sink.
28	0	24	72	4	1	Many mineral ores exist as sulfides. To obtain the metal, they are heated, creating sulfur dioxide.

Question	% A	% B	% C	% D	% No answer	Comments
29	7	39	44	10	0	Students should know that sulfur dioxide is very soluble in water, ultimately forming sulfuric acid. Hence, water sprays will remove it. A chimney contains very hot gases. A paper filter would not last long in the chimney of a mineral ore processing plant or power station. There is no reason to believe it would absorb much sulfur dioxide.
30	71	6	13	9	0	Sulfur dioxide is more dense than air. The negative 'not' may have confused some students.

Section B

Question 1a.

Marks	0	1	2	Average
%	5	61	34	**1.3**

Students needed to state a fossil fuel energy source. Full marks required some, at least brief, reference to both the infrastructure for getting to the island and the structure for producing electricity. Either could be emphasised, but both needed to be mentioned.

A port, undersea cable or need for shipping met the requirement.

Question 1bi.

Marks	0	1	2	3	Average
%	7	16	32	45	**2.2**

An excellent response would have been:
fossil fuel (chemical) → combusted (heat) → steam (heat) → turbine (kinetic) → generator (electrical)

Students needed to include all of the main steps and energy forms in order to score full marks. Partial marks were awarded for mentioning some or for mentioning energy steps without the accompanying conversions.

Question 1bii.

Marks	0	1	2	Average
%	8	30	62	**1.6**

In any conversion, the percentage energy efficiency is the desired output over the input × 100. Some of the input is converted into forms that are not the desired output; for example, in a generator, some input kinetic energy becomes heat rather than electrical output.

It was not necessary to give an example for full marks.

Question 1c.

Marks	0	1	2	3	Average
%	7	30	43	20	**1.8**

To score full marks, responses must have included at least implicit reference to all three concepts. Good responses made the point that it would be inefficient and costly to transport fossil fuel to the island, which has no fossil fuel.

Question 1d.

Marks	0	1	2	3	Average
%	4	9	29	58	**2.4**

One mark each was awarded for giving one positive and one negative impact, with a further mark for a description or an expanded answer.

Positive impacts included (but were not limited to): less greenhouse gas emissions, less mining disruption, renewable energy, more economic.

Negative impacts included: impact on views, noise pollution, habitat destruction, birds killed by blades.

Question 1e.

Marks	0	1	2	Average
%	10	33	57	**1.5**

Many non-fossil fuel energy sources are intermittent. Some need to store electricity in a battery for when there is no wind or sun. Alternative answers saying a battery was not needed because the non-fossil fuel energy source was not intermittent (for example, nuclear, geothermal) were acceptable and scored full marks.

Question 2a.

Marks	0	1	Average
%	33	67	**0.7**

A

Question 2b.

Marks	0	1	2	3	4	Average
%	8	13	20	24	34	**2.7**

- infrared (long wave and the abbreviation IR were accepted)
- re-radiated (or re-emitted)
- absorbed by greenhouse gases
- thus heating atmosphere

Question 2c.

Marks	0	1	Average
%	55	45	**0.5**

Water vapour is by far the largest contributor to the natural greenhouse effect. Many students obviously missed the word ‘natural’ in the question.

Question 2d.

Marks	0	1	2	Average
%	11	27	62	**1.5**

The natural greenhouse effect maintains temperature at a higher/warmer level, enabling life to exist on Earth.

Question 2e.

Marks	0	1	2	3	4	Average
%	4	6	16	31	43	**3.1**

Several gases were accepted: carbon dioxide, methane, chlorofluorocarbons, oxides of nitrogen, etc.

Carbon monoxide does not significantly absorb in the infrared region, so it does not contribute significantly. Sulfur dioxide does not remain as a gas in the atmosphere long enough to make a significant contribution.

There were many acceptable sources and methods of reducing the gas: scrubbers, alternative energy sources, less use of cars, etc. It was possible to score some marks in the later parts of the question even if the gas named was incorrect.

Question 3a.

Marks	0	1	2	3	Average
%	10	27	36	26	**1.8**

Three properties were required, including any of the following: liquid at room temperature, heavy metal, persistent in environment, conducts heat, conducts electricity, toxic, slightly volatile, exists in three forms (element, oxide/salt, methyl mercury/organic), etc.

‘Highly volatile’ was not accepted.

If students referred to solubility or bioaccumulation, they needed to specify which form. Elemental mercury is not soluble in water, so 'soluble' alone was not awarded a mark, but 'methyl mercury is soluble in fat', for example, would have been awarded a mark.

Question 3b.

Marks	0	1	2	Average
%	11	25	64	**1.5**

Students needed to describe at least two human health effects, such as neurological problems, the effect on the nervous system, muscle weakness, birth defects, kidney problems, etc.

Question 3c.

Marks	0	1	2	Average
%	19	36	45	**1.3**

Accepted responses for human-created sources of mercury include: gold mining, combustion of fossil fuels, disposal of electrical equipment and mercury lamps, fertilisers and fungicides.

'Ore-mining' alone was not awarded a mark unless the smelting process was included. Mining the ore does not release mercury.

Some students missed out on marks for describing sources of mercury that are not human-created (for example, volcanoes).

Question 3d.

Marks	0	1	2	Average
%	17	19	64	**1.5**

Students needed to explain whether the human-created source of mercury was point or diffuse and explain why.

Question 3e.

Marks	0	1	2	3	4	Average
%	14	20	28	25	13	**2**

This question was not answered well. 'Mercury carried by wind', for example, was not awarded any marks. In general, for both transport mechanisms, students had to refer to the chemical form of mercury in the mechanism. For example, 'mercury attaches to dust particles and is carried by wind' was accepted, as was 'methyl mercury is carried by sediment, as in dredging'.

Question 3f.

Marks	0	1	2	3	Average
%	27	24	21	27	**1.5**

The required points (or very similar) were:

- converted by bacteria
- into methyl mercury
- which is soluble in fat, and so it bioaccumulates.

Question 4a.

Marks	0	1	Average
%	55	45	**0.5**

The main term given to describe the natural vegetation on Kangaroo Island was 'remnant'. Some students used 'fragmented' or 'islandised' to describe the disconnected habitat remaining.

Question 4b.

Marks	0	1	2	Average
%	15	3	83	**1.7**

Most students were able to explain that the Green Carpenter Bee species is found on Kangaroo Island, but there are populations naturally existing on mainland Australia too. However, the Green Carpenter Bee is not unique to this location and therefore not endemic to Kangaroo Island.

Question 4c.

Marks	0	1	2	Average
%	3	42	55	**1.5**

As the major pollinator for the guinea flower, any reduction in the number of Green Carpenter Bees would negatively impact on the abundance of the plant population. A decrease in pollination would lead to fewer flowers being fertilised and, therefore, fewer seeds being produced. Students needed to clearly make a link between the bee's key role as a pollinator and the reproductive process of the guinea flower. It was evident that some students did not understand how the decrease in bees would have an impact on the biodiversity of the guinea flower.

Question 4di.

Marks	0	1	2	Average
%	4	24	73	**1.7**

A variety of possible advantages and disadvantages relating to the relocation of Green Carpenter Bees from the east coast of Australia to Kangaroo Island were provided by students. Points given as advantages mainly related to the benefits of increasing genetic diversity in the population or increasing the population size. Disadvantages included the possible introduction of disease into the Kangaroo Island population, the inability of the introduced bees to adapt to environmental conditions on the island or genetic swamping.

Question 4dii.

Marks	0	1	2	Average
%	7	39	54	**1.5**

The banning of fuel reduction burns within the patches of surviving vegetation maintains the existing habitat for the bees (an advantage). Disadvantages included the potential disastrous effects of larger bushfires in the future and less regeneration from seed by the guinea flower.

Question 4e.

Marks	0	1	2	Average
%	12	31	57	**1.5**

Management strategies included the following:

- a captive breeding program to increase the numbers of the bees, which could then be released into suitable habitats on Kangaroo Island
- strategies related to the establishment of wildlife corridors to link remnant habitats or artificial nesting sites for bee colonies.

'More monitoring in the recovery plan' was not a suitable strategy.

Question 4f.

Marks	0	1	2	3	4	Average
%	5	23	37	25	9	**2.1**

The focus of this question was on evaluating the arguments made by Thomas.

He argued that resources should not be wasted on protecting the bee because their extinction is inevitable. He also argued that because the bees were not easy to locate, tourists would not be drawn to see them. High-scoring students clearly evaluated these points, discussing the validity of such arguments and presenting valid counterarguments. A degree of judgment was required, with students making a recommendation.

Question 5a.

Marks	0	1	2	3	Average
%	13	37	37	13	**1.5**

There was a wide variety of responses to this question. One mark was awarded for a simple sampling method. A second mark was awarded for commenting on the need to take samples at different locations and at different times.

It was important that the method was appropriate. The scientific way of counting involves catching a sample, tagging it and releasing it. This is followed by catching a similar sample later and determining what proportion was tagged, that is, previously caught. From this ratio, the total number of fish in the lake can be determined.

A number of students described this method. The final mark was awarded for any reference to this 'capture → tag → release → recapture → analyse' technique.

Question 5b.

Marks	0	1	2	Average
%	5	18	77	**1.7**

Lake A

Species richness refers to the number of different species present. Lake A had six, and Lakes B and C had only five, so the answer was Lake A.

Question 5c.

Marks	0	1	2	Average
%	45	22	33	**0.9**

Lake B

Biodiversity, or species diversity, involves both species richness (number of species) and relative abundance. The relative abundance of Lake A is poor (dominated by Species W). Distribution is most even in Lake B.

Question 5d.

Marks	0	1	2	Average
%	8	13	79	**1.7**

17

Mean = $\frac{(30 + 47 + 70 + 40 + 60 + 5)}{6} = \frac{252}{6} = 42$

Sum of differences from mean: 12 + 5 + 28 + 2 + 18 + 37 = 102

So I = $\frac{102}{6} = 17$

One mark was given if it was clear that students knew what they were doing but made simple mathematical errors.

Question 5e.

Marks	0	1	2	Average
%	26	11	63	**1.4**

Species diversity has increased because a lower index indicates greater species diversity and the index has gone from 40 to 17.

Question 5f.

Marks	0	1	2	Average
%	29	33	38	**1.1**

This question required students to indicate that the relative abundance was more even and to support that in some way with reference to the data.

Question 6

The scenario set for Question 6 provided students with information related to the proposed development of a prawn farm at a coastal location. Students needed to use their understanding of environmental management processes and terms to answer the questions. They needed to have a clear understanding of the principles of ecologically sustainable development as well as the precautionary principle. This understanding was not always evident.

Question 6a.

Marks	0	1	2	3	Average
%	14	23	27	36	**1.9**

Most students used the ecologically sustainable development principle relating to 'using a resource to provide for current needs without depleting the resource for future generations'. They presented this idea clearly and explained how the prawn farm would provide prawns for consumers currently, taking the pressure off wild prawn stocks, thereby allowing numbers to be maintained for future generations. This suggested why the proposal could be considered an ecologically sustainable development.

Some students were able to use the concept of 'triple bottom line' and relate this to principles of ecologically sustainable development in their answer. Better answers using this approach included all three parts of the concept (economic, social and environmental considerations).

Question 6b.

Marks	0	1	2	3	Average
%	23	30	26	20	**1.5**

High-scoring students were able to take another principle relating to the 'development not causing negative environmental impacts' and explain how the prawn farm may have detrimental effects on the nearby beach through wastewater pollution or how it may have a negative impact on species that use the lagoon as a habitat. These students used this idea as a way of explaining why the prawn farm may not be considered an ecologically sustainable development. Low-scoring students used the same principle in parts a. and b. despite clearly being asked to use a different principle.

Question 6c.

Marks	0	1	2	3	Average
%	26	26	27	20	**1.5**

The precautionary principle was poorly understood by many students. A number of students simply took the term to mean caution was necessary when developing the prawn farm.

The main idea of the precautionary principle is that something should not go ahead if there is any scientific uncertainty.

In the scenario, wastewater from the prawn farm would be pumped into the lagoon, which would then flow out into the sea near a surf beach. The lack of scientific evidence (no recent data on threatened species) should not be ignored – an effort should be made to protect the lagoon even without data on the flora and fauna. This effort could include the establishment of the settlement pond even though the owner is arguing against it.

Question 6d.

Marks	0	1	2	3	Average
%	6	36	41	16	**1.7**

Students had a clear understanding of the key purpose of preparing an environmental impact assessment – to identify and outline the possible environmental impacts of the prawn farm development. Other relevant points included the need for public consultation to be included in the process, the use of information in the impact assessment in the decision-making process, and the outlining of possible alternative proposals and management actions.

Question 6e.

Marks	0	1	2	Average
%	29	34	37	**1.1**

Environment Protection Authority

Students were able to explain this organisation's role in setting acceptable standards regarding waste disposal, monitoring water quality in the lagoon and at the beach, and the implementation of procedures relating to any breaches of environmental regulations.

Low-scoring students named non-government organisations or the Environmental Protection Agency (which is the American organisation). Students should be able to give the full name of the relevant organisation, not just the acronym.

Question 6f.

Marks	0	1	2	3	4	5	Average
%	10	6	16	30	26	10	**2.9**

This question provided students with the opportunity to develop a more detailed answer with a coherent discussion and development of an argument related to the prawn farm proposal. High-scoring students were able to take the information provided and outline key arguments for and against the proposal (not simply re-list them). They discussed various benefits related to less bycatch, the sustainability of farming prawns for consumers and the economic value of jobs. Arguments against the development included the potential loss of species in the lagoon, the health impact of wastewater flowing into the sea and the visual impact of such a development on the coastal environment.

Based on these arguments, the students were able to make a clear recommendation relating to whether the proposal should be allowed to proceed or not. Many discussed the need for further environmental evaluation relating to the flora and fauna in the lagoon, as well as the benefit of actually having a treatment system and settlement pond for waste before the water is allowed to be released into the sea.