2011 Assessment Report

VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

2011 Environmental Science GA 3: Examination 2

GENERAL COMMENTS

Students performed well on the 2011 Environmental Science examination, although there was some evidence of students being unable to complete the examination in the allocated time. Students need to consider the way they plan and use the 90 minutes available for this exam.

It was evident that students had spent a significant amount of class time preparing to answer questions about specific case studies on a particular pollutant and an environmental project. The choice of suitable topics for both is a key to being able to write clear, relevant and specific answers. The selected case studies should allow for coverage of all areas of knowledge outlined in the study design. Case studies should include current information, relevant scientific techniques and significant figures/data. The ability to describe significant management outcomes that have been attempted or achieved is important.

Students should aim to develop a solid depth of knowledge related to both of the prescribed pollutants: sulfur dioxide and mercury. Specific knowledge about the chemical and physical properties, forms, sources, pathways, health impacts and management of both pollutants is required.

SPECIFIC INFORMATION

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	Comments
1	4	1	7	88	Chronic exposure relates to the exposure to a pollutant over a relatively long period of time.
2	89	8	2	1	A single smoke stack (one identifiable point of entry into the environment) is classified as a point source.
3	8	6	7	78	Bioaccumulation relates to the progressive increase of a substance (often harmful) in an organism, rather than increasing toxicity or exposure.
4	4	64	23	9	The statement related to elemental mercury vaporising at room temperature suggests that exposure to humans would be more likely as it evaporates into the air and can be breathed in. This would not lead to a high persistence or it being a waterborne pollutant.
5	4	84	2	10	Dosage refers to the amount of a chemical a person receives per unit of body weight.
6	4	2	91	3	The low levels of DDT remaining in the fields for years after being used as a pesticide demonstrate the chemical's persistence (that is, the ability to remain in the environment and not break down quickly).
7	1	9	86	4	For 22 of the 31 days in January, the levels of particles measured for air quality was at or below the national standard – that is, approximately 71%.
8	13	9	58	20	The graph only shows data for a one-month period; meaningful trends in scientific data need to be determined over a much longer time period.
9	4	87	7	2	The correct answer (option B – 0.043 ppm) was calculated by adding up the figures in the average nitrogen dioxide concentration column and dividing by six (the number of figures).
10	13	14	10	63	The correct ratio (option D – 727) for February 1 was gained by dividing 32 by 0.044 (that is, the figures for average particle and nitrogen dioxide concentrations on the day).

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Question	% A	% B	% C	% D	Comments
11	7	73	12	8	Synergism refers to the effect of the two pollutants when combined, producing a more harmful effect than when each of them acts separately. The hospital admission figures on February 3 and 4 indicate this effect; neither day has the highest figures for either pollutant, but both days have significant levels of each pollutant.
12	20	9	44	27	The idea that multiple air quality measurements would be taken by a scientist relates to the need to gain accurate data; data that is abnormally high or low can be excluded. An experimental 'control' relates to having a standard against which to measure a variable or variables during the experiment. A monitor would need to be assessed against known standards to measure its accuracy.
13	67	4	16	13	By investigating various stages of the production process and considering the issues related to the disposal of the product, the company is conducting a life cycle analysis before beginning manufacturing. A waste minimisation scheme would focus on developing ways to reduce waste levels, and an environmental management system tends to focus on risks and hazards, and developing policies and procedures to deal with these.
14	5	2	4	89	An environmental risk assessment would focus on identifying and quantifying any risks associated with the chemical. The management solutions are not usually part of this process.
15	1	2	3	93	As part of the environmental decision-making process, key stakeholders are usually consulted. These include a variety of groups and individuals who have a stake in or concerns about the project. These could include the proponent, relevant government agencies, community groups, local residents business organisations, etc.
16	90	9	1	0	The major focus of waste minimisation should be to reduce the amount of waste being produced, rather than finding ways to treat it, dump it or reduce the harmful impacts.
17	0	27	61	12	It is unlikely that there will be no environmental risks associated with the project (an undersea power line will disrupt the seabed, for example). However, an environmental impact assessment aims to acknowledge any such risks, consider options and balance them against the potential benefits of the project.
18	21	4	71	4	Consultation should provide an opportunity for those affected by potential impacts to have a voice in the decision-making process. It would be important to gain the views of local communities who may be affected by the construction of a power line.
19	83	10	3	4	An environmental impact assessment considers environmental issues more strongly than economic issues; therefore, financial costs and benefits are not as important in this process. Carbon emissions were considered to be more important compared to the visual impact on the environment.
20	6	2	52	40	The concept of ecologically sustainable development (ESD) includes the idea that we should meet the needs of current generations without compromising those of future generations. ESD acknowledges that there will be some damage to the environment through development, but that

Question	% A	% B	% C	% D	Comments
					this damage should be kept to a minimum wherever possible. Economic factors are not a key concept of ESD, and putting future needs ahead of current ones goes against the concept of ecological sustainability. By trying to develop renewable energy resources rather than using up all our non-renewable sources, we are aiming to meet the needs of current generations by still providing energy, but by providing it in a way that reduces our demand for non-renewable resources. These resources may then still be made available for future generations.

Section B

For each question, an outline answer (or answers) is provided. In some cases the answer given is not the only answer that could have been awarded marks.

Question 1

This question required students to answer in terms of a pollutant (other than mercury and sulfur dioxide) that they had studied in depth as a case study. The more successful answers showed a good depth and range of knowledge about a specific pollutant (common pollutants included nitrates, nitrogen dioxide, particulate matter, lead and phosphates) and included relevant examples where the pollutant had affected human or animal populations at particular locations.

The less clear answers confused the form in which the pollutant exists and changed from one pollutant to another throughout the parts of the question (for example, nitrogen to nitrates or phosphorus to phosphates). A number of students wrote about mercury, despite the instructions at the beginning of the question stating not to do so.

Question 1a.

Marks	0	1	2	Average
%	11	28	61	**1.5**

The question required students to indicate a geographic location where their named pollutant would be found. The more successful answers gave a specific location and a description of the site, indicating why the pollutant was found there. Some students included a natural source of the material (for example, lead in an ore body) rather than describing a location where the material could be classified as a pollutant (for example, lead in the soil as a result of waste disposal from a car battery recycling plant).

Question 1b.

Marks	0	1	2	Average
%	15	32	53	**1.4**

Students were required to explain how the particular pollutant is measured and indicate the units in which the concentration is expressed. Most students included the units, and many were able to describe the equipment and technique used to take measurements. It was evident that some students had undertaken a form of data collection using the equipment and could describe the methods they had used. Others had clearly investigated, through second-hand methods and case studies, data collection techniques related to their pollutant.

Question 1ci.–iii.

Marks	0	1	2	3	4	5	6	7	Average
%	4	2	4	7	11	23	33	16	**5**

1ci.
The major source of the pollutant needed to be described. The more successful students gave some detail related to the source. For example, rather than giving 'motor vehicles' as a major source of nitrogen dioxide pollution, detail was provided by explaining that nitrogen dioxide was emitted from the exhaust system of cars as a result of the combustion of petrol in the engine.

1cii.
Having indicated the source in part 1ci., students needed to identify this source as being either point or diffuse and correctly justify this source. Explanations containing the terms 'point' or 'diffuse' could have been improved by clarifying that a point source originates from a single, usually easily identifiable, point such as a chimney or discharge pipe, and that a diffuse source comes from a variety of points and can be more difficult to control. It was then important to explain how the pollutant source fits into either of these two categories. Many students included the concepts of mobile or fugitive emissions, although this was not required. The less successful students did not use the same pollutant source as they had used in part 1ci.

1ciii.
Descriptions of the major transport mechanism varied from simply correctly identifying the main method of transport (stating that the pollutant was carried by water currents) to providing a more detailed explanation of how it moves through the environment, which may have been linked to the form it is in, the particular environmental conditions and the way it was released into the environment. The question also required an estimation of how far the pollutant might be expected to be observed, having travelled by the particular transport mechanism from the source given in part 1ci.

Question 1d.

Marks	0	1	2	Average
%	13	23	64	**1.5**

Students needed to describe how their chosen pollutant is removed from or leaves the environment. The more successful responses flowed logically from the discussion in 1ciii. and clearly described the major sink. For example, after indicating how lead from an ore smelter chimney travelled via wind currents as airborne particles for relatively short distances and was washed out of the atmosphere during downfalls of rain, topsoils and water body sediments become the major sinks.

Question 1ei.–ii.

Marks	0	1	2	3	4	Average
%	6	8	15	32	39	**2.9**

1ei.
Being able to identify a particular population of humans or animals that had been exposed to the pollutant was again linked to having investigated specific case studies. Students who had obviously studied a situation where a pollutant had affected a population at a specific location were able to identify this and explain how the people of the population had been exposed to the pollutant. An example that used children in Broken Hill being exposed to airborne lead particles through inhalation or ingestion by eating or drinking contaminated food or water was a suitable case study.

1eii.
Students needed to accurately indicate the dosage required to cause significant harm to an individual of the particular population. A suitable dosage level needed to be given (that is, the amount of the chemical absorbed per unit of body weight), using an acceptable unit of measurement. For example, brain and kidney disorders would be likely to occur in children with a blood level concentration of over 100 micrograms per decilitre.

Question 1f.

Marks	0	1	2	Average
%	7	32	61	**1.6**

Students needed to describe a specific strategy that had reduced the risk of the pollutant affecting human or environmental health. The less successful answers were very general, lacking in detail about the strategy, gave a strategy that had not been implemented or mentioned a policy rather than strategy. A component of 'action' rather than a 'general plan' was needed. For example, students mentioned the Australian Design Rules as a strategy to manage nitrous oxide emissions, without providing any indication of how this would be implemented or what actions would

result from changes to the design rules. It is important that case studies investigated by students allow some scope to discuss management strategies related to the pollutant that have been implemented.

Question 1g.

Marks	0	1	2	3	Average
%	12	17	30	41	2

Students needed to evaluate the effectiveness of the strategy described in 1f. To do so, they needed to include some specific evidence (usually based on numerical data or results). In more successful answers, students were able to use figures that compared pre-management and post-management pollutant levels to comment on the effectiveness of the strategy. The less successful answers included detail about how the strategy could be improved; however, this was not the focus of the question.

Question 2

Students were expected to have studied both mercury and sulfur dioxide in some detail. Question 2 required them to use this knowledge, as well as use specific information provided about their pollutant. Most students' knowledge related to sulfur dioxide was good; however, some students were unclear about how the pollutant forms, its chemical properties, environmental pathway and suitable management strategies.

Question 2a.

Marks	0	1	2	Average
%	39	35	26	0.9

This question related to the generation of sulfur dioxide by a coal-fired power station. Many students had difficulty with the idea that coal contains a percentage of sulfur, which reacts with oxygen during the combustion process to form the sulfur dioxide. Many students wrote about sulfur dioxide being 'trapped inside' coal and being released when the coal was burnt, which was incorrect.

Question 2b.

Marks	0	1	2	Average
%	16	38	46	1.3

In general, students were able to list a variety of different characteristics of sulfur dioxide. The more successful answers included four different and relevant points such as colourless gas, a strong acrid smell, dissolves readily in water, denser than air, non-persistent and can attach to dust/soot particles to form particulates.

Question 2c.

Marks	0	1	2	Average
%	12	43	45	1.4

The more successful answers were able to describe specific effects on human health as a result of exposure to high concentrations of sulfur dioxide. Answers that included points such as the burning/irritation of mucous membranes in the lung/nose (which could be classified as acute effects) and respiratory illnesses such as asthma, bronchitis and heart disease due to long-term exposure (chronic effects) were appropriate.

Question 2d.

Marks	0	1	2	Average
%	21	41	37	1.2

This question required students to describe the processes involved in the formation of acid rain due to the emissions of sulfur dioxide from the chimney of a power station and include the likely transport mechanisms. Some students had difficulty in describing the process, but the more successful students were able to clearly explain that the emitted sulfur dioxide dissolves in atmospheric moisture to form sulfuric acid (H_2SO_4). Transport mechanisms mentioned included being windborne while still in small particle form or rainwater/runoff when it precipitates.

Question 2e.

Marks	0	1	2	Average
%	26	47	27	1

Many students had difficulty providing two acceptable methods by which power station owners could reduce the levels of sulfur dioxide produced by the station. Methods described by students included using coal containing lower amounts

of sulfur, using a scrubber system in the chimney to remove coal outputs, reducing power generation levels (and therefore coal combustion) and changing to renewable energy sources. Building a taller chimney does not reduce sulfur dioxide production; it simply releases the pollutant higher into the atmosphere. The idea of changing from using brown to black coal because this form contains less sulfur is also inaccurate.

Question 3

A wide variety of projects was used by students to respond to Question 3. Projects that provided depth to students' responses included water conservation/management projects, waste reduction at sewage treatment plants, road construction projects and channel dredging in Port Phillip Bay. Students who wrote about their pollutant case study as an example of an environmental management project struggled to respond in detail.

Question 3a.

Marks	0	1	2	3	Average
%	4	7	29	60	**2.5**

Students were generally able to clearly outline the key aspects of their particular project, including the general goals and major outcome (which was not necessarily an environmental aim). Successful answers provided a clear description of the project and what it had achieved so far. Many students had obviously practised writing an 'introduction' to their particular project and included detail about a specific location and time frame. These were not part of the question; students must focus on the specific points required in each question.

Question 3b.

Marks	0	1	2	3	Average
%	12	16	40	32	**1.9**

This question required an indication of a process used to review/outline the environmental impacts of the project before the project was approved. Most students were able to identify that an environmental impact assessment or environmental risk assessment had been used and gave some description related to how this had been carried out (such as a detailed project outline was prepared, data related to impacts was collected and cost/benefits or risks/hazards were identified). The less successful students tried to describe how the project had been evaluated after the project was completed.

Question 3c.

Marks	0	1	2	Average
%	7	26	67	**1.6**

Students needed to identify two major environmental aims or objectives that were established before the project commenced. Most were able to provide two specific examples related to the particular project and give some detail about each objective. For example, a mining project established the aim of limiting the number of times noise from mine explosions exceeded decibel limits to fewer than four per year. Students need to be careful about listing more than the requested number of examples; they should choose the best two examples and focus on these in their answer.

Question 3d.

Marks	0	1	2	3	Average
%	15	15	33	37	**1.9**

Students needed to explain what actions were taken to achieve each of the aims and objectives in 3c. Students were generally able to provide relevant detail related to the methods put into action to achieve these objectives. Often this task seemed easier for students who had made site visits to the project and had observed actions taken by the project managers.

Question 3e.

Marks	0	1	2	3	Average
%	16	21	41	21	**1.7**

The question required students to name a specific organisation responsible for environmental monitoring of the project. In questions such as this, students should give the full name of the organisation; for example, Environmental Protection Authority, rather than the acronym 'EPA'. It should also be noted that the Environmental Protection Agency is the American, not the Victorian organisation. Students then needed to explain the relevant regulatory guidelines used in the monitoring and evaluation of the project.

Question 3f.

Marks	0	1	2	3	Average
%	16	16	35	33	**1.9**

Students needed to use the two environmental aims or objectives from Question 3c. and evaluate how effective the project had been in meeting them. Students needed to provide evidence to support their argument. The more successful students gave a clear justification related to the success or otherwise of the project in meeting the particular environmental aims and usually supported this with specific data (often quantitative).

Question 4

It was important that students carefully read the information provided and used and interpreted this information (both the written outline and map) in their answers; they should not have simply copied points from the introduction.

Question 4a.

Marks	0	1	2	3	4	Average
%	2	2	13	52	31	**3.1**

This question required students to review the information provided and to select key points related to social, economic and environmental arguments used both for and against the mining proposal. A table format was used to support the organisation of this information, and most students were able to successfully summarise relevant factors into the correct sections.

Question 4b.

Marks	0	1	2	3	4	5	Average
%	10	3	15	33	30	9	**3**

Students needed to analyse the various pieces of information and develop a balanced and coherent evaluation. There were arguments in favour of mining going ahead (mainly based on the economic points related to the money generated from the sale of the metal and the number of jobs created) and the proposal not being approved (mainly based on the potential environmental impacts on the river and woodland). The more successful students highlighted a number of these key points and, based on the information, made a clear recommendation regarding whether the proposal should proceed or not. For example, while some students noted that pollution of the river could occur if the tailings dam was flooded, this would be unlikely if levee banks were created and the design of the dam was suitable. This, combined with the topsoil storage and the seed bank-based revegetation program, indicated that environmental damage would be minimised. Monitoring and regulation of dust levels meant that the major economic value of the project (billions of dollars of revenue and 300–400 jobs over a number of years) would result in the project being given approval. Clarity of thinking, organisation and flow of points, and logically presented arguments are important when responding to this type of question. It should be noted that some students wrote about the possible impact on 'locally threatened' woodland species as if the entire species would become extinct if the mine went ahead.

Question 4c.

Marks	0	1	2	3	Average
%	16	15	38	31	**1.9**

Students needed to present an argument based on the information provided as to whether or not the proposal should be considered as an ecologically sustainable development (ESD). Students should have incorporated a number of the key principles of ESD in their answers. For example, having made a statement that the proposal should be considered as an ecologically sustainable development, they argued in this way because the mining development meets the needs for metals and provides jobs at present. Others argued that the mine was not a sustainable development as ecological processes were not being considered enough because of the serious threats to the woodland and river ecosystems.

Question 5a.

Marks	0	1	2	Average
%	9	28	62	**1.6**

Students needed to describe an example of an ecotourism activity or business. The description should have given a clear, basic idea of what the activity involves and of the ecotourism focus. Many students were able to describe well-known businesses such as the Phillip Island Penguin Parade, the Otway Treetop Walk and Port Phillip Bay dolphin cruises. Some examples were very basic and general (for example, a zoo or going snorkelling).

Question 5b.

Marks	0	1	2	3	Average
%	15	17	35	33	**1.9**

Based on the activity or business described in 5a., students needed to identify and clearly describe two relevant environmental impacts (these could be either positive or negative impacts). Some suggested impacts were very basic and could have been more specific to the business or activity. Students who had visited the particular ecotourism place described were usually able to provide relevant impacts.

Question 5c.

Marks	0	1	2	3	4	Average
%	18	13	25	31	13	**2.1**

This question required some higher-order thinking skills. Students needed to make a comparison between their ecotourism example and the description of Greentree Lodges, with respect to each activity's ability to meet two ecotourism criteria. Having identified the two criteria (such as having minimal negative impact on the environment when undertaking the ecotourism experience), students needed to indicate how successful their ecotourism example and the Greentree example were in meeting each criterion. Both examples needed to be discussed, two ecotourism criteria needed to be identified and there should have been an element of comparison (for example, one example was more successful in meeting the criteria than the other). It should be noted that while many ecotourism activities use some of their income for the development of programs with positive environmental impacts, this is not a specific requirement or criterion for categorising an activity as ecotourism.