VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

2010 Environmental Science GA 3: Examination 2

GENERAL COMMENTS

Students responded well to the 2010 Environmental Science examination 2 and there was little evidence of students being unable to complete the examination in the allocated time.

A number of students had difficulty with questions that required them to perform calculations. Students should be prepared for questions that require basic mathematical use of data, including percentage calculations. Students need to read the stem of multiple-choice questions carefully, use the information or data presented and then consider the most suitable answer choice.

It was evident that a significant amount of class time had been spent on preparing students to answer questions about specific case studies on a pollutant and an environmental project. The choice of suitable topics is the key to being able to write clear, relevant answers. When selecting a pollutant and an environmental project to be studied, teachers should ensure that the associated case studies allow for coverage of all areas of knowledge outlined in the study design. For example, if there have been no management strategies implemented for dealing with a particular pollutant, then this would not be a good choice of pollutant. The availability of actual data is also important in considering which case studies to investigate.

Students should not write prepared answers or try to write everything they know in response to a question. They must read each question carefully, use the information provided in the exam booklet and apply their knowledge specifically to the question asked.

Students' depth of knowledge about sulfur dioxide and mercury as pollutants was good. It was evident that some of the more successful students had investigated both pollutants in detail. These students were able to write about sources, transport mechanisms, sinks, specific characteristics, forms of the pollutant, human health and environmental effects (including dosage, exposure and toxicity), and management techniques and strategies.

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	% No Answer	Comments
1	2	80	16	2	0	A single power station (with a chimney releasing sulfur dioxide) can be regarded as a point source.
2	10	70	7	12	0	Students needed to have an understanding of key terms related to pollution. The individual experienced health problems when exposed to low levels of sulfur dioxide, while most other people do not. This was an example of the person having an allergy to this pollutant.
3	19	70	6	5	0	Chemicals that are soluble in fatty tissue tend to be bioaccumulated (not excreted easily). Students should be aware that a gaseous chemical can still be absorbed into the body.
4	6	11	72	12	0	A Life Cycle Analysis should include investigation into the effects of a product throughout all stages of its life – raw material extraction, production, use and eventual disposal.
5	3	6	9	82	0	Most students recognised the link between photochemical smog and pollen producing more cases of asthma as an example of synergistic action.

Question	% A	% B	% C	% D	% No Answer	Comments
6	11	1	74	14	0	A major focus for community and environmental groups should be to encourage responsible environmental practices. These groups may comment on the consequences of regulatory frameworks but do not usually conduct the assessment.
7	9	61	26	4	0	An Environmental Impact Assessment (EIA) should attempt to identify the various effects of a particular proposal, in this case a mobile phone manufacturing activity. An Environmental Management System would focus on how to best address identified environmental problems and develop processes to reduce these effects.
8	15	72	3	11	0	The plan as outlined attempts to address the potential risks of mobile phones ending up in landfill through waste minimisation.
9	1	71	11	17	0	The potential fines that could be imposed by the Environmental Protection Authority are part of the regulatory framework. The regulatory framework could also include other penalties (such as shutting down the activity), organisations with legislative authority and guidelines related to emission limits.
10	20	12	4	63	0	The Environmental Impact Assessment process should allow for public consultation on the proposal and therefore input from the local community. Potential environmental impacts should be outlined, as well as recommendations regarding ongoing monitoring. The report would include recommendations to the Minister regarding the viability of the project (and possible alternative options) but not the Minister's final decision.
11	1	4	3	92	0	Most students were able to interpret the data from the graph correctly. The lowest recorded gas concentration was 0.04 ppm at 9 km north of the city.
12	3	13	84	1	0	Of the 21 recorded gas concentrations, 14 were below the government's target of less than 0.12 ppm. This is approximately 67%.
13	4	44	6	46	0	Students needed to consider the likely explanation for the distribution of the pollutant gas across the city. The higher recorded concentrations to the south of the city were due to a point source being located there (possibly 5 km to the south). The decline in gas concentrations from 5 to 10 km south would be an argument against the wind factor; therefore, option B was the correct answer.
14	64	1	3	31	0	More data would be required to draw this conclusion (option A), given that the gas concentrations were recorded on one day only.

Question	% A	% B	% C	% D	% No Answer	Comments
15	38	6	35	21	0	Students seemed to have difficulty with the calculation required. The concentration measured at 1 km north was 0.10 ppm, therefore over 4 minutes Angie would have been exposed to 0.40 ppm (remembering that exposure considers the length of time). Although 0.15ppm was recorded at 6 km south, Angie was only exposed to the pollutant for two minutes (a total of 0.30 ppm).
16	8	4	14	74	0	Dosage refers to the amount of the chemical absorbed per unit of body weight. Option D related to the amount absorbed by Angie's body while she was at the site. Option C included the reference to time that relates to exposure.
17	7	44	24	25	0	The calculation for the percentage decrease in water entering the wetlands was: 10 960 – 6970 = 3990 gigalitres decrease 3990 ÷ 10 960 = 0.36 x 100 = 36%.
18	13	22	40	25	1	Students needed to focus on the concept of ecological sustainability and consider the accuracy of the four statements. A key environmental impact would be the decrease in water flowing into the wetlands, and therefore this could lead to a loss of wetland ecosystems. This is much more significant than the impact of less fresh water flowing into the sea, and domestic/irrigation demands are not focused on ecological needs – there is more focus on social and economic needs.
19	1	17	17	66	0	A key aim of an Environmental Risk Assessment should be to weigh up the advantages of the proposal or to project against the disadvantages (or potential risks).
20	3	19	54	24	0	While the provision of resources (such as hydroelectricity generation and domestic water supply) for future generations is an issue when discussing sustainability, option C focused on the sustainability of the environment itself – the river from which the water is being transferred must still have an adequate flow to protect the aquatic ecosystem.

Section B – Short answer questions

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 or sulfur dioxide, that they had studied in depth as a case study. Some less successful students attempted to describe a greenhouse gas as a pollutant; however, this choice did not allow the depth required to use greenhouses gases as a specific case study. Carbon monoxide and water vapour were also poor choices as pollutants due to a lack of sufficient data to investigate these pollutants in depth and as applied to a specific case study.

Students were expected to have a considerable depth of knowledge of their chosen pollutant. Some students, however, were not clear about the form in which the pollutant exists, and changed from one form to another throughout the question parts; for example, nitrogen to nitrates or phosphorus to phosphates.

Question 1a.

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

The question required students to link the named substance to the concepts underlying the question 'what is a pollutant?' Students needed to indicate how the pollutant is added to the environment through human activity (anthropogenic sources) and how it causes harm or could be potentially harmful. A number of students did not describe how their pollutant was added to the environment.

Question 1b.

Marks	0	1	2	3	Average
%	15	28	39	17	**1.6**

Students had some difficulty in identifying a specific method used to measure their pollutant and describing the technique in detail. A number of students could not correctly identify a unit in which the concentration is expressed.

In their study of a pollutant, it is expected that students will have had the opportunity to take measurements of the pollutant, and have gained an understanding of the measurement techniques and the units in which the concentration of the pollutant is recorded. Alternatively, students could have studied second-hand data and have a thorough understanding of how the data was collected. Laboratory or fieldwork using specific equipment and techniques to measure for pollution samples would be useful. Viewing scientists at work via the Internet or video could also be considered.

Question 1c.

Marks	0	1	2	Average
%	7	34	59	**1.5**

The question required students to describe a specific location or situation where the pollutant occurs. A number of students gave very general examples, such as 'in a city'. Some students tried to describe the source of the pollutant.

Question 1d.

Marks	0	1	2	3	Average
%	9	15	33	44	**2.1**

Students needed to describe the main characteristics or properties of their pollutant and how these contributed to the way the pollutant functions within the environment. For example, 'Lead is fat-soluble (property) and therefore is likely to be absorbed into fatty tissue within the body rather than excreted (function)'. Most students were able to list relevant properties. The more successful students described major characteristics clearly.

Question 1e.

Marks	0	1	2	3	4	Average
%	6	7	24	29	35	**2.8**

Students needed to state one major direct and one major indirect effect of the pollutant. To gain full marks, students should have then described how these affect either human or environmental health. For example, 'A direct effect of

high levels of exposure to lead could be anaemia, nausea, gastric problems, headaches or high blood pressure in humans. An indirect effect occurs when lead is deposited on the leaves of plants, presenting a possible hazard to grazing animals'.

Most students gave a detailed explanation of the effects of the pollutant on humans and/or the environment, although a number of students confused the terms 'direct' and 'indirect'.

Question 1f.

Marks	0	1	2	Average
%	7	35	58	1.5

Students needed to describe a specific strategy that had reduced the risk of the pollutant affecting human or environmental health. Student responses were generally well done. The less successful answers were very general, lacked detail about the strategy or gave a strategy that had not been implemented.

Question 1g.

Marks	0	1	2	3	Average
%	10	15	44	31	2

Students needed to evaluate how effective the strategy described in 1f. had been. To do so, their case study should have had an element of completion; some strategies had not been implemented, thereby limiting the student's response. The more successful answers included an element of judgment of the effectiveness of the strategy and supported this judgment with evidence and data. To gain full marks, students needed to describe a realistic improvement to the strategy.

Question 2

Students were required to have studied mercury and sulfur dioxide in some detail and Question 2 required them to use this knowledge. Some students were well prepared and had a clear understanding of the forms of mercury, their sources, transport mechanisms and possible effects to health.

Question 2a.

Marks	0	1	2	Average
%	11	13	77	1.7

Students were able to identify the lamp globes as being either a point source (if they identified a landfill site as a single, identifiable, localised source of mercury pollution) or a diffuse source (if they explained that more than one landfill site spread the source of pollution, or if they discussed many individual lamp globes spread throughout a large landfill site). Many students also wanted to include a 'mobile' source in their answer; however, this was not required, and was not relevant to the question.

Question 2b.

Marks	0	1	2	3	4	Average
%	16	19	29	24	11	2

Students were required to discuss elemental mercury; however, some students discussed methyl mercury. Students needed to outline the transport mechanism (windblown in the atmosphere since it is gaseous and insoluble in water), and major sink (deposits from the atmosphere onto solid surfaces like concrete or soil where it is oxidised into a less volatile form, and eventually washes into the ocean and settles into sediments). Physical and chemical characteristics referred to included that the elemental form could not be destroyed chemically or thermally, insolubility in water (therefore can bioaccumulate in fat tissue) and high volatility (vaporises at about 11 $^{\circ}$C and therefore is a gas at ambient temperatures).

Question 2c.

Marks	0	1	2	Average
%	40	7	53	1.2

Based on the figures presented in the table, it was clear that a lower quantity of inorganic mercury salts can be tolerated over the same time period (0.01 compared to 0.1 mg/m^3 as a maximum 8-hour exposure limit). Therefore, the inorganic salts are more toxic than the organic methyl mercury form.

Question 2d.

Marks	0	1	2	Average
%	76	4	20	**0.5**

The dosage of methyl mercury received over an 8-hour period by an 85 kg person was 0.004 mg/kg. This was calculated by dividing 0.34 by 85. A number of students did not include units, which were specifically asked for in the question. A large number of students gave 0.425 mg per hour as their answer (gained by dividing 0.34 mg by 8 hours); however, this was incorrect.

Question 2e.

Marks	0	1	2	Average
%	39	3	58	**1.2**

To calculate the mass of methyl mercury, students needed to use the half-life of 50 days as the basis. Therefore after 50 days, 0.40 mg would be left (0.80 ÷ 2); after 100 days 0.20 mg would be left (0.40 ÷ 2); and after 150 days 0.10 mg would be left (0.20 ÷ 2).

Question 2f.

Marks	0	1	2	3	Average
%	20	12	54	15	**1.6**

The advantage of setting a maximum level based on chronic exposure limits is that it minimises the risk of toxicity due to long-term bioaccumulation/persistence in body fat.

Students needed to distinguish between chronic exposure (contact with the substance over a long time, often more than six months) and acute exposure (contact that extends for only a short time, usually no more than 14 days). Some students focused only on the difference between chronic and acute exposure without suggesting an advantage of the setting maximum levels based on chronic exposure, and this limited the quality of their response.

Question 3

A wide variety of projects were used by students to respond to Question 3. Projects that allowed students access to specific information and data and included a site visit provided the basis for many successful responses. Some students tried to answer the question using an ecotourism project or the management of their threatened species as a 'project', both with very limited success. The narrow focus of a basic air pollution monitoring project limited the depth of some students' responses.

Question 3a.

Marks	0	1	2	3	4	Average
%	4	2	13	34	47	**3.2**

Most students had a solid basic knowledge of their case study. They were able to provide a clear description of the project, including the major outcome, a number of general goals and the location where the project occurred. Some answers lacked specific identification of a time frame (beginning and end dates).

Question 3b.

Marks	0	1	2	3	Average
%	6	9	34	51	**2.3**

The more successful students described the specific environmental aims of their project clearly. Some students had difficulty indicating key stakeholders responsible for implementing these aims. Most could list some stakeholders, but those listed were not necessarily responsible for implementing the environmental aims.

Question 3c.

Marks	0	1	2	3	Average
%	22	21	33	24	**1.6**

Students were asked to outline a key environmental management process (tool or strategy) used to determine the potential environmental impacts of the project. The more successful students were able to describe how an Environmental Risk Assessment or an Environmental Impact Assessment had been used to identify and evaluate the possible impacts of their project before it was undertaken. A number of students attempted to describe how a Life Cycle Analysis had been used to assess impacts, although in many cases this was an unlikely management method.

Question 3d.

Marks	0	1	2	3	Average
%	21	13	34	32	**1.8**

Students needed to identify relevant regulatory groups (such as the Environmental Protection Authority, local councils and catchment management authorities) and outline how these groups were involved in setting specific guidelines and monitoring the project to determine if these guidelines were being met. The less successful students used the project developers/managers as the regulatory/monitoring organisation. Students were expected to use the full and correct name of the organisation; for example, not just 'EPA' or 'Environmental Protection Agency'. Some students had a poor understanding of the role and function of regulatory groups, especially the responsibilities of the Environmental Protection Authority in Victoria, and confused interest groups with specific groups involved in setting regulations and monitoring compliance. Other students wrote about State Environment Protection Policies (SEPPs) as though they were a regulatory group rather than legislative guidelines.

Question 3e.

Marks	0	1	2	3	4	Average
%	15	7	21	34	23	**2.5**

The question required students to evaluate how effectively the environmental aims described in 3b. had been met. This required a level of judgment based on data to support the evaluation, usually in the form of quantitative data. Students whose project was yet to be completed found it difficult to answer the question.

Question 4

Information was provided for students to read and analyse for use throughout the question. It was important that students used and interpreted this information in discussing their answers; they should not have simply copied out points from the case study and used them solely as their response.

Question 4a.

Marks	0	1	2	3	Average
%	14	19	41	26	**1.8**

The question required students to give a basic outline of the steps required in an Environmental Impact Assessment: conduct research/collect information and prepare a report, allow for public consultation and comment, review by a decision-making body. Students needed to give a description of what should be included in the final report: an outline of the need for and objectives of the proposal, a description of the proposal and alternatives, a description of the current environment, the likely environmental impacts resulting from the options, as well as recommended safeguards to minimise potential impacts and make overall recommendations to the relevant Minister.

Question 4b.

Marks	0	1	2	3	Average
%	10	14	41	35	**2**

Students needed to identify three relevant stakeholders; for example, city residents, coastal residents, state government, local government, environmental groups, bird watchers, the railway company. They then needed to describe the consultation process; for example, public exhibition of the EIA, collection of comments/feedback through public meetings and written submissions.

Question 4c.

Marks	0	1	2	3	4	5	Average
%	13	4	15	31	28	8	**2.9**

The more successful students highlighted key points of Jenny's arguments, such as the negative impact on the wetland/river ecosystems due to changes in water flow, increased salinity causing habitat loss, and the negative aesthetic impact due to the loss of the ocean view. These students compared those key points to Richard's key points, including the railway being more environmentally sustainable rather than using cars as the main form of transport, the tunnel is much more expensive than the causeway, wildlife would adjust to changes in the wetlands, and the causeway is better environmentally. After summarising the key points, students needed to analyse the arguments, such as commenting on the strength/validity/balance of the two view points. The more successful answers were well constructed and organised, indicated that Jenny was focused on environmental/social aspects (ignoring economic considerations) while Richard made comments on environmental/social and economic aspects; students then gave a clear, overall judgment in favour of one side or the other.

Question 5a.

Marks	0	1	2	Average
%	16	46	38	**1.2**

Students needed to analyse the information related to the fictional wildlife sanctuary and comment on the ecologically sustainable aspects of the operation: the protection of threatened species and their habitat, lodges built from recycled materials using sustainable energy forms. This was balanced against the culling of the bettongs, a threatened species, which is against the concept of protection of a threatened species, but does provide some protection for the Indigenous grassland. In justifying a viewpoint on the ecological sustainability of the sanctuary, students needed to make clear to what 'ecological sustainability' refers – the use of resources to provide for current needs without compromising the ability for future generations to have access to these resources.

Question 5b.

Marks	0	1	2	3	Average
%	14	26	44	15	**1.6**

Some students discussed negative environmental impacts of culling – the loss of approximately 20% of bettong species in sanctuary – or they focused on the positive impact of protecting the Indigenous grassland and other threatened species by reducing bettong numbers. Consideration of both positive and negative impacts was necessary. A large number of students suggested other more suitable strategies such as the relocation of bettongs to a suitable mainland habitat (where they are endangered) or expanding the sanctuary habitat and limiting population growth in the bettong population.

Question 5c.

Marks	0	1	2	3	Average
%	16	15	40	28	**1.8**

Students needed to identify two suitable ecotourism criteria and relate them to the wildlife sanctuary. These included the promotion of ecological sustainability by conserving grasslands and protecting endangered species, providing tourism and educational opportunities in an environmental setting – tourists have the opportunity to work with scientists and learn from them – and having minimal environmental impact through the design of lodges using recycled materials, minimising water and energy resources. The more successful students indicated two basic criteria and then linked these criteria clearly to how the sanctuary functioned.