VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

2009 Environmental Science GA 3: Examination 2

GENERAL COMMENTS

The 2009 Environmental Science examination was of appropriate difficulty and length, with little evidence of students being unable to complete the examination in the allocated time. Students performed well on the Multiple-choice section, although Questions 8, 12, 17 and 20 proved challenging. The calculation questions were not well answered and students are advised to practise these types of questions to improve their skills. However, overall there was an improvement in the standard of responses to the examination when compared with previous years.

The trend towards teaching the study using in-depth case studies regarding local issues continued again this year. Generic questions relating to a specific case study (Questions 1 and 3) were well done. Teachers are encouraged to continue to use this approach and focus on student learning through field, laboratory and data analysis work related to specific case studies. Students who had the opportunity to visit sites relevant to their pollutant and/or environmental science project were able to write with greater clarity and specific knowledge. The analysis of data is of particular importance in both cases, especially in regard to the effectiveness of environmental management strategies used to deal with risks and impacts. It is therefore generally better to select a case study which has been completed and allows evaluation of the overall project and specific outcomes.

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	6	4	30	60	0	The significant key to sulfur dioxide's harmful impact on the environment is its solubility in water to form sulfuric acid. This negatively impacts on, for example, plant growth, aquatic ecosystems and soil structure.
2	62	12	10	15	0	Students need to understand the difference between exposure, dosage and toxicity.
3	72	15	8	4	0	
4	1	2	16	81	0	Given that synergism refers to a combined result being greater than the effects of the two separate pollutants, it would be expected that more than 15% of people exposed might be hospitalised.
5	8	86	2	4	0	
6	66	17	8	8	1	Questions 6–8 required knowledge of the pollutant mercury, which must be studied in Unit 4.
7	91	6	1	2	0	
8	10	38	12	40	0	Students found this calculation very difficult. 25 x 500mg = 12 500 mg Given that 55% of this is emitted from the chimney (45% is removed by the scrubbers), $\frac{55 \times 12\,500}{100}$ mg = 6875 mg. Therefore the best answer was option B.
9	15	17	61	8	0	The distribution pattern of the graph indicates that mercury is dense (that is, greater concentrations of the mercury particles are found in the soil within 500 metres of the plant's chimney).

Question	% A	% B	% C	% D	% No Answer	Comments
10	22	66	8	3	0	The concentration of mercury in soil 600 metres from the plant chimney was 80 mg per 100 g of soil. Therefore a 350 g soil sample contains 3.5 x 80 mg = 280 mg.
11	4	1	3	92	0	
12	36	54	7	2	0	The process of bioaccumulation requires a progressive increase in the amount of a substance in an organism, especially in animals higher up the food chain.
13	64	10	24	2	0	Methyl mercury is fat soluble and therefore is more likely to be stored in the body (bioaccumulated) rather than excreted. Students needed to understand the different forms of mercury and the characteristics of each.
14	5	9	84	3	0	
15	0	1	8	91	0	
16	14	1	2	83	0	
17	58	22	15	6	0	The description of the Environmental Impact Assessment did not include any consideration of what might happen to the energy generation system over its operation life, and what might happen to the turbines when they are decommissioned (worn out and needing to be replaced). This means that the Life Cycle Analysis component has been overlooked.
18	11	6	80	3	0	
19	1	3	68	28	0	As a government body, the Environmental Protection Authority in Victoria has clear legal powers to set and monitor guidelines related to noise limits. This is an example of a regulatory framework.
20	20	36	32	11	1	Students found this calculation very difficult. To calculate the percentage of power required from the gas turbine: $\frac{7.2 + 4.3 + 2.5 + 3.3}{4} = \frac{17.3}{4} = 4.325.$ Therefore 4.325 is the average number of hours per day (over the year) when the wind speed is below 10 km/h, and therefore the gas turbine needs to be used. $\frac{4.325 \times 100}{24 \text{ (hours)}} = 18.02$ % (option C)

Section B – Short answer questions

Note: Student responses reproduced herein have not been corrected for grammar, spelling or factual information.

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 was one of two 'generic' questions on the paper (the other was Question 3) and required students to answer in terms of a pollutant (other than mercury and sulfur dioxide) which they had studied in depth as a case study.

Students were expected to have a considerable depth of knowledge on the pollutant. Many students wrote clearly about specific examples of pollutants such as lead, nitrogen dioxide and phosphates, in particular situations. Better answers showed the depth of the investigation students had completed, including a clear understanding of the form or forms the pollutant exists in. Poorer answers tended to be very general and used pollutants such as carbon dioxide, litter, salt and detergents without identifying specific forms, properties and clear examples of a source. Some students continually changed the chemical form of the pollutant throughout their answers in Question 1 (for example, from orthophosphate to phosphorus to phosphate).

Question 1a.

Marks	0	1	2	Average
%	6	30	64	**1.6**

The question required students to describe a specific situation or location in which the nominated pollutant is found. Some description related to an actual situation or location was required for full marks.

Question 1b.

Marks	0	1	2	3	Average
%	7	13	33	47	**2.2**

Students needed to describe properties of their pollutant which they then clearly related to the harm it caused to either humans, animals or the environment. Better answers clearly described at least two properties and made the link between each property and the harm caused. Some poorer answers simply listed a variety of properties that were not necessarily related to harm. In using phosphate as an example students needed to be able to clearly explain its role in the process of eutrophication and the environmental problems this leads to.

Question 1ci.

Marks	0	1	2	3	Average
%	7	7	17	70	**2.5**

Students needed to describe a major source of the pollutant and indicate whether this was a point or diffuse source. The reason for the classification as either point or diffuse needed to be given. Most students were able to give an example of a major source and correctly classify this source. There was some confusion in the explanation of the classification and some poorer answers jumbled the source terms 'point', 'mobile', 'diffuse' and 'fugitive'.

Question 1cii.

Marks	0	1	2	Average
%	11	18	71	**1.6**

The major transport mechanism for the particular pollutant was usually clearly identified. Better examples were able to describe how the pollutant, in the particular form, was either airborne (for example, as a dust particle or aerosol) or carried by water.

Question 1ciii.

Marks	0	1	2	Average
%	17	29	54	**1.4**

The natural sink for the particular pollutant needed to be described. Most students chose to describe the final resting place of the pollutant, such as being incorporated into the sediments at the bottom of a lake where it remains unless the lake bed is disturbed.

Question 1d.

Marks	0	1	2	3	4	5	6	Average
%	10	5	11	18	28	19	9	**3.4**

Some students found this question challenging as it required them to incorporate a number of different parts in a clear description of a specific example of a population of organisms (animal or human) that has been exposed to the particular pollutant. Students needed to have studied a specific example that they could then use to cover the level of exposure in this case, dosage that would cause harm to the population and numerical data that would indicate exposure

and/or dosage levels. The answer also needed to include a clear differentiation between the terms 'exposure' and 'dosage'. Poorer answers lacked specific data, did not use correct units for dosage/exposure levels, did not relate to a specific population, jumbled the meaning of exposure with dosage and incorrectly included acute/chronic terms.

Question 1e.

Marks	0	1	2	3	4	Average
%	11	6	19	32	32	**2.7**

Some students found this question challenging as it required them to incorporate a number of different parts in a clear description of a specific example of the population of organisms (animal or human) used in Question 1a. The effectiveness of this management strategy also needed to be evaluated based on actual data. Better answers were based on a suitable management strategy that had been put into action (students who used strategies that were not implemented found the question difficult) and included a clear judgment related to the effectiveness of this strategy using numerical data as evidence. A number of students did not relate the strategy back to the particular population and location used in Question 1a.

Question 2

Question 2 focused on students' understanding of the pollutant sulfur dioxide. Students are required as part of their coursework to have studied both mercury and sulfur dioxide.

Question 2a.

Marks	0	1	2	3	Average
%	11	15	32	43	**2.1**

Most students were able to describe two basic chemical or physical properties of sulfur dioxide, including it being a colorless vapour with a pungent odour which is soluble in water to form a weak sulfuric acid (H_2SO_3) solution.

Question 2b.

Marks	0	1	2	3	4	Average
%	10	7	24	21	38	**2.7**

Students were asked to describe two impacts of sulfur dioxide on human health or on the environment. Most chose to describe the impact of the sulfuric acid solution that forms from sulfur dioxide reacting with water. This included explanations of how the sulfuric acid could cause lung damage when inhaled and the impact of acid precipitation on lake ecosystems, plant growth and marble/concrete corrosion, etc.

Question 2c.

Marks	0	1	2	3	Average
%	9	5	8	77	**2.6**

Most students were able to correctly plot the points on the graph of sulfate ion concentration versus pH. Values on the *y*-axis (4–6 or 0–6) and 0.0–0.9 on the *x*-axis were included. It was not necessary to join the points with a line.

Question 2d.

Marks	0	1	2	Average
%	18	57	25	**1.1**

The relationship between sulfate ion concentration and pH represented on the graph needed to be clearly described. Some students did not understand the pH scale and acidity levels.

The following is an example of a good answer.

> *A strong inverse relationship between sulfide ion concentration and pH is shown on the graph; when sulfate ion concentrations increase the pH decreases (ie. the rainwater becomes more acidic).*

Question 3

Question 3 was a generic question related to the study of an environmental project. Given that this is a major part of the study, students are expected to have a thorough understanding of their case study. Generally students were well prepared (especially if they had visited the project site) and were able to write clearly about their particular project. Some students tried to write about the monitoring of the pollutant they had studied as their environmental project, which in some cases was not an effective way to cover some parts of the question.

Question 3a.

Marks	0	1	2	3	4	Average
%	3	2	6	32	56	**3.4**

Students needed to clearly describe the key elements of the project, including the aims, its specific location and the relevant time frame (that is, when it started and finished or if it continues). In answering this question it was important that students gave sufficient detail about the environmental aspects of the project. For example, some students wrote about the building of a bridge across an estuary system with the aim of improving traffic flow at the particular location, and also included a description of the methods used to minimise environmental impacts during the construction period.

Question 3b.

Marks	0	1	2	3	4	5	Average
%	8	8	27	26	21	10	**2.8**

A population or environment that had been clearly affected by the project needed to be indicated. These effects may have not yet occurred and could have either been positive or negative. Many students wrote about the positive impacts the project had on a particular population of either humans or animals. A form of consultative process that related to the project then needed to be described, including some indication of those involved in the consultation process. Students then concluded their answer with an evaluation of the adequacy of this consultation process. This judgment should have based on a form of clear reasoning and/or supporting evidence. Some students were unclear about a consultation process and confused this with data collection.

Question 3c.

Marks	0	1	2	3	Average
%	19	23	24	34	**1.7**

The question allowed students to describe an environmental management plan that had resulted from an assessment of risks or impacts related to their project. The description of the particular management plan needed to indicate some specific actions or strategies to deal with the risks or potential impacts. For example, some students wrote about the specific strategies put in place to deal with possible risks from a mining project related to dust hazards and noise pollution. Poorer answers lacked a clear understanding of the concept of management plans.

Question 3d.

Marks	0	1	2	3	4	Average
%	20	7	18	29	26	**2.4**

Students were required to evaluate the success of the environmental management plan (or strategies) put in place to deal with potential risks or impacts. Evaluation required some form of judgment related to the success (or failure) of the plan. A clear statement related to this judgment needed to be based on some form of data (which was usually numerical).

Question 4

Question 4 presented a large amount of information related to an unknown environmental science project based on two scenarios with the aim of increasing the water supply to Adelaide. The basis of this question was the students' ability to analyse, synthesise and evaluate the arguments presented for each scenario. It was not simply a case of rewriting the basic arguments given by Paul and Hayley.

Question 4a.

Marks	0	1	2	3	Average
%	9	8	27	56	**2.3**

Three groups who should have been consulted as part of the decision-making process needed to be indicated. Students needed to give a reason why each group should have been consulted. For example, a group that could have been consulted were water users in the Great Artesian Basin because they would potentially be negatively impacted on by the removal of water from the Basin. Some students were confused by the RAMSAR Convention and thought it should be consulted.

Question 4b.

Marks	0	1	2	3	4	5	6	Average
%	6	1	7	12	27	35	12	**4.1**

The question required students to summarise the main arguments given by Paul and Hayley. The better answers were well structured, clearly highlighted the main ideas being presented by both proponents and finished with a comment on the major difference between the two cases. Students highlighted key aspects of Paul's argument for using the Ord River Scheme as the source of water and included points such as:

- a new dam does not need to be built as the Ord River system has already been dammed (therefore the environmental impact of dam building has already occurred)
- concerns related to the impact of using water from the Great Artesian Basin. These include the lowering of the water table, salinity issues, impact on native animals from reduced spring flow and damage to RAMSAR Convention protected wetlands and the bird species that use them
- pollution problems resulting from increased greenhouse gas production from electricity generation required for a desalination plant used to desalinate the Artesian Basin water.

Hayley's main arguments for Adelaide using water from the Great Artesian Basin included:

- the comparative costs which favour the Artesian Basin Scheme (that is, capital costs of $2 billion versus $11 billion and ongoing costs per year of $61 million versus $400 million)
- the much higher supply costs to Adelaide consumers of the water from the Ord River Scheme (that is, $9.30 compared to $6.60 per 1000 L) and the negative impact of this on the Adelaide economy
- concerns related to the distance water would have to travel from the Ord River in northern Western Australia (that is, losses due to evaporation, energy costs and extra infrastructure requirements).

While Paul's arguments focused on pointing out the negative aspects of using the Great Artesian Basin water, he was also mainly concerned with environmental considerations as opposed to Hayley's arguments, which were based on economic points.

Question 4c.

Marks	0	1	2	3	4	5	Average
%	16	4	14	28	27	11	**2.8**

Having analysed both sides of the water supply debate, students were required to evaluate the relative merits of each argument. This required some form of comparative judgment in favour of one proposal over the other. This overall judgment needed to be clearly stated and should have been based on reference to the strength of the arguments of Paul compared to Hayley, and include specific comment on the data in both table 2 and 3. Some better students used ecologically sustainable development (ESD) principles and the concept of the triple bottom line as a basis for comparison.

Question 5a.

Marks	0	1	2	3	Average
%	11	21	37	32	**1.9**

Most students showed a clear understanding of the concept of ecologically sustainable development and how the Tahune Forest Airwalk complies with this concept. The accepted definition of 'ecologically sustainable development' usually included the idea of 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' Better definitions also included a focus on development that was sensitive to ecological processes and requirements. Students explained how the Airwalk was constructed with minimal tree removal and disturbance, used existing road networks for access and used a site that had previously undergone logging. These factors meant that the Tahune Forest Airwalk was meeting the needs of the current generation for access and education in a forest environment, but had been developed in a way to minimise environmental impact and allow the ecosystem to continue to be viewed and available to be used by future generations.

Question 5b.

Marks	0	1	2	3	Average
%	15	4	27	54	**2.2**

Students needed to name and briefly describe a specific ecotourism business. Having identified a business, they needed to explain how this activity meets two criteria or key performance indicators of an ecotourism development. Relevant criteria or indicators include development that is sensitive to the particular environment it exists in, operating in a manner that does not pollute or damage the particular ecosystem, the ongoing sustainability of the development and a focus on educating people about components of the particular environment. This educational activity could include an experiential or immersion in the ecosystem focus.