VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

2004 Environmental Science GA: 3 Written examination 2

GENERAL COMMENTS

Teachers of this subject are to be commended for their good preparation of students again this year. It is obvious that teachers are increasingly working in the spirit of the course by focusing on in-depth studies of a specific pollutant and environmental project, and teaching the key concepts through these. With the changes to the biodiversity section in Unit 3, which now requires an in-depth study of one endangered animal, the whole course is now consistent in using in-depth studies as the preferred approach. These in-depth studies are examined by what are termed 'generic' questions, that is, students respond in terms of their in-depth studies. Short answer Questions 1 and 3 on this paper were generic questions. In writing the examination, the panel attempts to set questions which allow students to use the detailed case studies they have undertaken, and also to set scenario questions which encourage students to respond by referring to what they have learned in their specific studies. Again this year, the trend was towards good, explicit responses to generic questions, with a lowered occurrence of very generalised answers. The examination marking scheme favours very specific responses that reflect the students' in-depth studies.

Careful attention should be paid to some of the 'task' words used on the paper. Students should be aware of the different requirements of various instructions in questions:

- name/nominate: simply state. For example, name a pollutant – carbon monoxide
- define: requires a description that identifies and differentiates the term or concept
- describe: requires giving some properties of the subject. For example, describe the pollutant – a pink liquid, volatile, lower density than water, toxic to humans
- outline: briefly give an overview of the main features or issues. For example, outline a management plan – list measures to safeguard the environment, set up equipment to monitor emissions, establish acceptable limits, determine whether limits are met, and if necessary modify the procedure
- evaluate: requires a judgment based on evidence or data
- compare: list similarities and differences.

In particular, if the question asks for an evaluation, a mere description will not achieve full marks. Some element of judgement must be present, preferably supported by some evidence, for example Questions 1d and 3c.

SPECIFIC COMMENTS

Section A – Multiple-choice

Questions in this section included a number with a scenario or interpretative style rather than simple definitional type questions, although some of these were, and will continue to be, used. Students should be familiar with the interpretation of graphs. They can expect to do simple calculations such as the determination of averages and concentrations, and hence should have encountered and become familiar with simple units of measurement such as volume, mass and concentration.

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

	A	B	C	D	No answer
Question	**%**	**%**	**%**	**%**	**%**
1	4	8	80	7	0
2	8	14	0	78	0
3	81	3	5	10	0
4	3	3	2	93	0
5	6	13	77	5	0
6	1	28	5	66	0
7	24	18	38	19	0
8	95	1	4	1	0
9	23	3	69	5	0
10	89	2	5	4	0
11	1	4	13	82	0
12	31	5	47	16	1
13	14	73	5	8	0
14	70	3	20	7	0
15	83	4	4	10	0
16	14	78	5	3	0
17	2	2	84	12	0
18	38	17	31	14	0
19	19	44	10	26	0
20	30	32	20	18	1

Questions 1 – 4
These questions were intended to test students' knowledge and understanding of simple concepts in the course. They were intended as a straightforward introduction to the paper, which they proved to be.

Questions 5 – 7
This block tested some of the key knowledge concepts in a scenario situation (decontaminating a polluted site), and included a simple calculation.

Question 7 proved difficult, with only 38% of students responding correctly. The common misunderstanding, leading to responses A or D, seemed to be that the aim must be to prevent any environmental negatives at all. Students should learn that almost any activity will have positives and negatives; decisions are made to balance these and to try to reduce the negatives, but they will almost never eliminate negative consequences.

Questions 8 – 10
This block was another scenario, which tested students' interpretation of graphs and their understanding of the characteristics of pollutants – transport mechanisms, sinks, and point and diffuse sources.

As carbon monoxide is a gas of approximately the same density as air, and high levels were observed when the wind was coming from the north, its transport mechanism is obviously wind (Question 8 – A), and it has come from Melbourne (Question 9 – C), which is due north of Cape Grim and the closest major city to it.

A sink (Question 10 – A) is the mechanism for removing carbon monoxide from the environment.

Questions 11 – 13
This block of scenario questions tested field and practical work skills and students' ability to interpret and manipulate data; skills students should have encountered and used in their course.

Questions 11 and 13 tested students' knowledge of and ability to apply two concepts – dosage referring to the amount of gas absorbed per unit mass, and exposure affected by length of trial.

For Question 12, trial 3, with 0.4 ppm of ozone alone, destroyed only 16 out of 50 plants (approximately ⅓). In trial 6, 10 ppm of sulfur dioxide destroyed 36 plants (approximately ⅔). However, when combined in trial 7, they destroyed almost all the plants. This showed synergistic action (reinforcement), which was option C. This question proved moderately difficult (47% of students got the correct answer).

Questions 14 – 17
This block of scenario questions tested graphical interpretation and the manipulation of data.

In Question 14, an environmental indicator is something that can easily be measured which indicates the health of the environment. It may or may not be harmful, hence answer A is correct.

In Question 15, there were two days (days three and four) out of 20 above 3 500. Therefore, the percentage of unsafe days was: unsafe $= \frac{2}{20} \times 100$
$= 10\%$ (option A)

In Question 16, without doing any mathematical calculation, all are above 100 (hence not A), only two are above 3000, (hence not C or D) therefore, the answer must be option B – 1000. The actual exact value is about 910; 1000 is clearly the best estimate.

In Question 17, the concentration rises suddenly and rapidly on day three, then drops back over three days to the usual levels. An overflow of sewerage systems is the only possible cause, as continual discharge would not cause any abrupt change.

Questions 18 – 20
These questions tested the students' ability to analyse data in a laboratory type experiment, where the waterborne transport of pollutants with different characteristics was simulated. This block of questions proved demanding, though there was a moderate correct response rate.

In Question 18, the flow rate was increased, which would have the most effect on the fine sand (option A).

In Questions 19, the increase of air flow over the surface caused more evaporation, which would most affect the volatile pollutant (II), so B was the correct option.

In Question 20:
volume = cross-sectional area x length
volume per sec = cross-sectional area x length per sec (that is, speed in ms^{-1})
volume of water per sec = $0.020\ m^2 \times 0.50\ ms^{-1}$
$= 0.010\ m^3$
$= 0.010 \times 1000$ litres/second
$= 10$ litres/second
Therefore, the correct option was D. This question had a very low correct response rate. The common error was obviously not converting to litres/second as required, even though the volume in m s^{-2} was correctly calculated.

Section B – Short answer
As in previous papers, there were two questions (1 and 3) which were 'generic', that is, they were to be answered in terms an in-depth study conducted during the year. On a positive note, students' responses this year continued to be quite specific, although some responses still lacked details such as names, dates, quantities and evidence. As students obviously have the opportunity to prepare these areas, quite specific detail is expected in these questions.

Question 1
This was a generic question on the pollutant that should have been studied in-depth through the year. Students should know the properties of the pollutant they have studied, both physical (for example, solid/liquid/gas, density and volatility) and chemical (for example, solubility and reactivity), and its effects on the health of humans and/or the environment. They should be able to relate these to the characteristics of a pollutant; its origin, source (how it enters the environment), transport mechanism, health effects (exposure, toxicity) and sink (both how it would naturally dissipate from the environment and how it is removed or reduced by management).

Again, source and transport mechanisms were generally well dealt with in student responses, although sinks and dissipation were less so. Some students seem to think of a sink specifically as a plug hole of some kind, rather than as any mechanism that breaks down or removes the pollutant from the environment.

Students should be able to relate the properties of the pollutant to its characteristics and behaviour. They should know management strategies for dealing with the pollutant and its effects, and should use specific evidence and data to evaluate the effectiveness of such strategies. In selecting the pollutants to be studied, teachers should bear in mind that the study of the selected pollutant must allow students to discuss its characteristics and history in the environment, and to evaluate the effectiveness of measures to deal with it. Teachers are encouraged to select a reasonably localised pollutant that has a clear strategy for dealing with it. Very general pollutants, for example air pollution, made it difficult for students to attain the required specificity compared with a more defined situation, for example emissions from cars and efforts to reduce them in the Melbourne metropolitan area in the period 1990 - 2000.

Question 1a

Marks	0	1	2	3	Average
%	2	24	39	35	**2.1**

A correct response needed to mention two separate properties of a pollutant. For full marks, the properties had to be defining of a pollutant. The two most obvious were that a pollutant is:

- introduced into the environment by human action
- harmful to the environment.

A common inadequate answer was that a pollutant must persist in the environment for a long time. This is not defining of a pollutant – there are some serious pollutants that have a short life.

Question 1b

Marks	0	1	2	3	Average
%	1	5	47	47	**2.4**

The material named had to be a pollutant. The answer was required to refer to the two properties described in Question 1a, and to relate these to the nominated pollutant.

Question 1c

Marks	0	1	2	3	4	5	6	Average
%	0	1	3	6	18	28	45	**5.1**

Students were required to describe the source, transport mechanism, environmental effect and method of dispersion of the nominated pollutant. One error, although not very common, was to give a very general definition of the terms with little or no reference to the nominated pollutant.

Question 1d

Marks	0	1	2	3	4	Average
%	4	5	21	43	28	**2.9**

This question required both a description of a management plan and the evaluation of the plan's effectiveness. Evaluation, as described above, implies some judgment, preferably supported by evidence. A common error was to describe a management plan but make no reference to any evaluation. This error occurred particularly when the pollutant described was very general, with no specific period of study.

Question 2

This was a scenario question relating to a flood that caused the release of three pollutants from a factory. In general, a variety of answers were accepted for partial marks if they were supported by logical reasoning, even if not completely correct.

There were clearly some students with little understanding of the term 'organic liquid'. Some seemed to have been misled by the misuse of the term 'organic' in the retail, media and advertising areas. An organic material is one containing carbon bonding. Although students were not expected to have this level of detailed knowledge, science students at this level are expected to have a general idea of the correct meaning of organic.

Question 2a

Marks	0	1	2	3	4	Average
%	10	15	37	23	15	**2.2**

Pollutant I:

- transport mechanism: airborne (light, volatile, insoluble). Hence it will float on the surface of the water and quickly evaporate. The wind will carry it towards the north
- sink: it will return to the earth and be broken down in soil.

Pollutant III:

- transport mechanism: waterborne (soluble in water). It will run off with stormwater to the south and into the bay
- sink: it will be dispersed in the bay/ocean and ultimately absorbed by plants.

Question 2b

Marks	0	1	2	3	Average
%	35	18	17	31	**1.4**

This question was poorly answered. On average, students gained less than half of the available marks, and many scored zero (generally because they had left the question blank). The only pollutant well north of the factory would be I, the light volatile liquid, as its transport mechanism was airborne. Although there was no obvious mechanism for getting the other two pollutants well north of factory in a short time, other responses were awarded part marks if they were supported by some logical reasoning. For example, some candidates opted for II (the heavy metal particulate), arguing that a strong enough wind could carry them.

Question 2c

Marks	0	1	2	3	Average
%	8	26	40	26	**1.9**

- pollutant I (volatile organic liquid): north of factory, as it is airborne and hence carried north by the wind
- pollutant II (heavy metal): on the ground, reasonably close to and south of the factory
- pollutant III (nitrate salt soluble in water): dissolved in water in the bay.

This question was generally well answered. For reasons not clear, many students who were unable to answer Question 1b correctly (that the light, volatile liquid was found north of factory) did correctly answer this question, including that the volatile liquid would be the only one north of the factory.

Question 2d

Marks	0	1	2	3	4	Average
%	22	17	17	31	13	**2.0**

Pollutant II, the heavy metal. It would bioaccumulate in fish high up the food chain (but not in plants, although this detail was not required for full marks). The other two pollutants would have dispersed by a year later.

Many diverse answers were given to this question, and part marks were given for other answers with a logical explanation.

Question 2e

Marks	0	1	2	3	4	Average
%	6	12	33	34	16	**2.4**

Two reasonable measures were required. For example, levies or banks to contain the leakage; better storm water drainage to prevent floodwater entering the factory; storage higher up. Answers which simply suggested 'fix the storage bins' or 'move the factory' did not get full marks.

Question 3

This was a generic question on an environmental science project. As students were able to prepare this question in detail in advance, more specific information, such as locations, time frames and outcomes, was expected. While a wide variety of projects could be chosen (either positive environmental projects or the negative environmental consequences of a major project), we emphasise the advantage of a project which is time and place limited (that is, has an obvious closure) so that its effectiveness can be evaluated; for example, to avoid environmental damage during the construction of a particular section of freeway.

Question 3a

Marks	0	1	2	3	4	Average
%	2	6	27	40	26	**2.8**

In this question, specific details were favoured over generalisations. The aims needed to be explicitly articulated in the answer. The description should have given the reader a good image of the project – its location, time frame and aims. Some responses left the reader still in the dark as to exactly what the project was about and where; just naming the project was not sufficient for full marks.

Question 3b

Marks	0	1	2	3	4	Average
%	5	7	26	36	26	**2.7**

This required at least two impacts of the project to be mentioned. The impacts were required to refer specifically to the project described, and to have at least some environmental connection. For example 'to shorten travel times' was not considered an environmental impact.

The question required evaluation of the positives and negatives. 'Evaluate', as outlined above, implies some judgement, with reasons/evidence for the judgment. A small number of students simply mentioned two impacts, and made no attempt to compare or evaluate.

Question 3c

Marks	0	1	2	3	4	Average
%	11	10	33	29	17	**2.3**

This question required a description of a plan for monitoring the project; obviously, given the diversity of projects, a wide variety of responses were rewarded. Again, specificity was favoured over generality.

Half the marks were given for the evaluation part of the question. Again this required a judgement about success, which was to be supported by some reason or evidence.

Question 4

This question described a project with both positive and negative environmental implications; the construction of an electricity generating wind farm.

Question 4a

Marks	0	1	2	Average
%	6	54	40	**1.4**

The main purpose of an Environmental Impact Assessment is to guide those who have to make decisions about a project. Full marks required some reference to the decision process, while part marks were given for many of the other widely diverse answers given.

Question 4b

Marks	0	1	2	3	Average
%	17	13	42	28	**1.8**

The surveys were inadequate because of the limited sampling time; the time of day and season of year tested were both too narrow. The fact that no orange-bellied parrots were detected in the sampling shows that it was inadequate, because this is a known habitat and it was essential to get information on these birds.

There was a wide variety of responses to this question, and part marks were given for reasonably relevant comments.

Question 4c

Marks	0	1	2	3	4	Average
%	8	13	33	31	15	**2.3**

Two marks were given for the mention of two issues, other than the effect on wildlife, which should be addressed by the EIA, and a further two marks for a measure to address each issue. A wide variety of issues were accepted, so long as there was some reasonable comment. Issues accepted included visual or aesthetic impact, environmental damage during construction, noise pollution, effect on farmland, effect on tourism, life cycle costs, comments on the relative efficiency

of wind farms versus other energy sources, the effect of the required extra infrastructure (roads, power lines) and many others.

Question 4d

Marks	0	1	2	3	4	Average
%	19	18	21	22	20	**2.1**

This question required the mention of two factors relating to a long term or life cycle issue. Acceptable issues included the environmental cost of construction, maintenance and refurbishment over the life of the plant, the cost of decommissioning, disposal of material, restitution of land at the end of usage and many others.

Question 5

This question related to a scenario of a tunnel on a freeway.

Question 5a

Marks	0	1	2	3	Average
%	20	8	16	56	**2.1**

The freeway acts as a diffuse source, since pollutants originate over an extended area (the length of the freeway) rather than a particular point. For full marks, some indication of the meaning of point and diffuse sources was required.

One mark was given for answering 'point source' if there was a significant, meaningful reason given which included a clear understanding of point and diffuse sources.

Question 5b

Marks	0	1	2	3	4	Average
%	16	17	24	22	21	**2.2**

The first type, larger particles, was heavier and would therefore fall to the ground relatively close to the source. The second type, being airborne, would be carried considerable distances by the wind in dry weather. Because they are reasonably soluble, in wet weather they would be carried down to earth closer to the source, hence less would be carried five kilometres away.

This question was also relatively poorly answered. Although there was little evidence of students not completing the paper, perhaps some were rushed on the last question.

Question 5c

Marks	0	1	2	3	4	Average
%	14	23	31	23	9	**1.9**

An environmental risk assessment should consider the following factors:

- exposure; that is, how much of each pollutant the local population is exposed to and will absorb
- the toxicity of each pollutant
- the persistence of each pollutant in the environment
- other relevant factors.

Scientific terminology was favoured over general descriptions in the marking of this question. Many students gave very general answers, with little use of scientific terminology.