2003 Environmental Science GA 1: Written examination 1

GENERAL COMMENTS

Teachers are becoming more aware of the general direction of the course and expectations for the examination. Compared with last year's examination, there was less evidence of students being well prepared for some sections and ill-prepared for others. The length of the examination seemed appropriate, with few students being unable to complete the paper due to time constraints.

The setting panel attempted to reflect the emphasis in the course on actual detailed studies rather than on a bank of memorised facts; as evidenced by short-answer Questions 3 and 4, which followed the same pattern of 'generic' questions used previously. In previous reports emphasis has been placed on specificity of response, and this was better this year. Students' responses regularly showed specific examples, geographic locations; similarly in the generic type questions. While not encouraging extensive prepared responses, the examiners believe that where the question asks for a response in terms of an in-depth study that has been undertaken as part of the coursework, more specific detail can be expected.

SPECIFIC INFORMATION

Section A – Multiple choice

This table indicates the approximate percentage of students choosing each distractor. The correct answer is the shaded alternative.

Question	A %	B %	C %	D %	Selected comments
1	1	3	95	1	Most students correctly chose C – wind – as the energy source not producing greenhouse gases. The common incorrect response was B – biomass – presumably on the basis that it is not a fossil fuel; however, methane, a significant greenhouse gas, is a product of this process.
2	1	9	86	4	Most students correctly identified C – burning of coal in power stations – as directly contributing to the greenhouse effect. The most common incorrect response was B – destruction of the ozone layer. Students need to be very clear about the distinction between the greenhouse effect and ozone depletion.
3	20	66	1	13	Many students responded correctly to this question: that the greenhouse effect is caused by atmospheric absorption of radiation (infra-red) re-emitted from the Earth's surface. Most others chose A – direct trapping of incoming solar radiation. The differential absorption of incoming solar radiation (largely visible and some ultraviolet) and re-emitted infra-red is central to understanding the greenhouse effect.
4	2	78	11	9	Most students correctly chose B – higher sea levels – as an effect of the enhanced greenhouse effect, with no obvious pattern of incorrect responses. This question, and Question 3, attempted to test students' understanding of the difference between natural and enhanced greenhouse effect.
					Questions 5 and 6 tested students' knowledge of the general concepts of energy and energy efficiency outlined in the study design. They were not particularly well done.
5	14	50	27	9	Question 5 asked what percentage of the energy contained in the original coal reaches the end user, that is the overall efficiency: $0.93 \times 0.30 \times 0.90 = 0.25$ or 25% (B)
6	21	17	50	12	Question 6 asked about the specific process of burning within the power station which is 30% efficient; hence 70% is not converted: $70\% \times 6\,000 = 4\,200$ kJ (C) The inverse (30% of 6 000 = 1 800kJ) was deliberately not given.
7	61	15	23	1	This question sought knowledge of the simple definition of species richness (the number of different species in a location), and was rather poorly answered.
8	1	18	1	80	Simple knowledge of the term 'ecosystem diversity' – the variety or types of communities, habitats and processes – was sought here. The common incorrect response was B (variety of plants and animals in a particular ecosystem), confusing ecosystem diversity with species richness.

9	10	5	11	74	Loss of competitors (D) is clearly not a threat – rather an advantage. There was no obvious pattern in the incorrect responses, other than presumably missing the **not** in the stem.
10	14	8	76	2	This question simply required knowledge of the term 'endemic' – specific to a particular location.
					Questions 11 to 13 tested students' ability to apply exercises and fieldwork undertaken in coursework to a scenario type situation.
11	1	85	5	9	Question 11 tested simple knowledge of threat levels and was well done.
12	9	33	48	10	Less than half of students were able to do the simple calculations required in Question 12. The examiners expected that students should have done similar analyses as part of either actual fieldwork or using simulated data. The study design clearly states students should undertake fieldwork, simple analysis and the calculations implicit in these.
13	8	58	15	19	Question 13 tested knowledge of some of the simple terms relating to protection of biodiversity; in particular the Precautionary Principle, which is explicitly mentioned in the study design, and to differentiate this from other terms.
14	73	9	18	0	Questions 14 and 15 tested the section in the study design: 'assessment of risk. Including estimation of extinction.' Despite being asked in almost the same format as that of last year's examination, Question 14 was relatively poorly done. More practice on this type of calculation is warranted.
15	11	79	7	3	Question 15, requiring recognition that a larger population size will make extinction less likely, was well done.
16	78	1	1	20	In Questions 16 and 17, treaties, agreements and regulatory frameworks are a section in the study design, and these two questions tested application of treaties to particular situations. It is not expected that students will have explicit knowledge of particular treaties; hence sufficient information on CITES was given in the stem.
17	0	69	5	26	
18	9	0	2	89	This question tested the need for protection of biodiversity, and was very well answered.
19	78	5	16	1	Some basic knowledge of scientific terms related to energy as enumerated in the study design was tested in this question, and it was well done.
20	68	13	14	5	This question explained the function of the Kyoto protocol (which would not be assumed knowledge) and then asked for an interpretation of what would support it. It required some interpretation, and so proved slightly more difficult – reasonable for the last question in the section.

Section B – Short answer

Question 1a

Marks	0	1	2	3	4	5	6	Average
%	4	4	17	25	19	17	14	3.61

This question examined students' understanding of the mechanism of the greenhouse effect. The report on last year's examination drew attention to lack of understanding of this mechanism, in particular of the role of the different types of radiation involved (Ultraviolet, Visible, Infra-red). Some guidance was given to students on aspects that should be included in their responses, and the marking scheme closely followed these.

A diagram was necessary to obtain full or almost full marks. Full marks were obtainable with a labelled diagram only (a significant number of students drew a detailed diagram with no written response). However, the labelling had to be very clear and comprehensive for full marks.

The types of solar radiation had to be explicitly mentioned. The Sun's energy reaches the outer atmosphere of the Earth mostly as visible and ultraviolet. Much of the ultraviolet is absorbed in the upper atmosphere; hence most radiative energy reaching the surface is in the visible. This is absorbed by the Earth's surface, and, because of the lower temperature of the surface, re-emitted as infra-red. Because the so-called greenhouse gases in the atmosphere (CO_2, H_2O and others) absorb far more in the infra-red than visible, they are heated by absorbing this re-emitted infra-red radiation, while allowing the visible (and some UV) to reach the surface.

For full marks, some reference to temperature or heating was required. The mechanism of the greenhouse effect is central to this part of the course, and teachers should ensure students are aware of the basic facts, especially the role of the different types of radiation and the differential absorption of them.

Question 1b

Marks	0	1	2	Average
%	10	20	70	**1.59**

This question required students to name a greenhouse gas which has increased due to human activity, and to describe its source. Water vapour was allowed, provided the source related to human activity.

Question 1c

Marks	0	1	2	Average
%	75	14	11	**0.36**

Concentration in 1800: 280 ppm; in 2000, approx 360 ppm. Increase: 360 – 280 = 80 ppm % increase = $^{increase}/_{original}$ x 100 = $^{80}/_{280}$ x 100 = 29%.

A wide range was allowed, and marks were given for partial correct working but wrong answer. It is hoped that interpretation of graphs is a skill that students would have encountered in field, practical and project work.

Question 1d

Marks	0	1	2	Average
%	5	15	80	**1.75**

This question was well done, and any reasonable comment was rewarded.

Question 1e

Marks	0	1	2	Average
%	9	17	74	**1.65**

This item was well done. The most common error was to give an effect of the natural (rather than enhanced) greenhouse effect, for example keeps Earth warm enough to sustain life.

Question 1f

Marks	0	1	2	Average
%	4	19	77	**1.73**

Generally, almost any reasonable strategy was rewarded. For full marks the answer had to relate to the **enhanced** greenhouse effect. Strictly speaking, a treaty (e.g. Kyoto protocol) is not a strategy, although this was given some marks.

Relating generally to the last two questions, teachers should emphasise more obviously the distinction between the natural greenhouse effect (necessary to sustain life on Earth as we know it) and the enhanced greenhouse effect (which may have undesirable consequences).

Question 2a

Marks	0	1	2	3	Average
%	20	16	6	58	**2.01**

Petrol: CO_2 emitted = 12.0 x 2.5 = 30 Kg

Diesel: CO_2 emitted = 10.0 x 2.7 = 27 Kg

Therefore diesel released less CO_2 than petrol in travelling 100 km in this test.

Question 2b

Marks	0	1	2	Average
%	14	24	62	**1.48**

For full marks, heat in some way needed to be mentioned.

Question 2c

Marks	0	1	2	Average
%	9	13	78	**1.68**

A wide variety of responses was allowed here. The answer sought was, for example, cheap, relative safety, wide availability etc. Some students interpreted this question as referring to petrol rather than diesel. If it was obvious that this was how they had interpreted it and they made a reasonable comment, the response was rewarded.

Question 3
The study design requires knowledge of one fossil and one non-fossil energy source, and one renewable and one non-renewable energy source. It is assumed that to meet this requirement, students in class will have studied one example of each of these in a detailed case study in some depth. These were tested in the two generic questions – Questions 3 (fossil/non-fossil) and 4 (renewable/non renewable). Because of the expectation of an in-depth study, reasonably specific and detailed responses were looked for in marking.

Some students seem to have not been completely clear on the distinction between fossil and renewable. There are some non-fossil, non-renewable sources, e.g. uranium. Some identified all fossil with all non-renewable.

Question 3a

Marks	**0**	**1**	**2**	**3**	**4**	**Average**
%	2	6	29	28	35	**2.86**

Reason for being considered a fossil energy source required some reference to decayed living matter as the source. Since the question explicitly asked for it, full marks required some reference to some emission.

Question 3b

Marks	**0**	**1**	**2**	**3**	**4**	**Average**
%	12	8	20	28	32	**2.60**

Compared to last year, responses to this were much more specific, with less very general answers (such as ‘a windy place’ for wind power or ‘a sunny place’ for solar). As part of a reasonably in-depth study in coursework, a quite specific response was looked for.

Question 3c

Marks	**0**	**1**	**2**	**3**	**Average**
%	9	16	36	39	**2.05**

Students needed to make at least some passing reference to each of the points in the question, including some reference to life cycle impact and emissions. Successful answers were sometimes observed from students who underlined or highlighted the key points in the question.

Question 4
Question 4 was the generic question on renewable/non-renewable energy sources. (See general comments on generic questions under 3 above.)

Question 4a

Marks	**0**	**1**	**2**	**3**	**4**	**Average**
%	3	2	12	27	56	**3.30**

Question 4a was quite well answered.

Question 4b

Marks	**0**	**1**	**2**	**3**	**4**	**Average**
%	8	6	21	49	16	**2.58**

Question 4b required some ‘second order thinking’, that is comment on an argument, and predictably resulted in a spread of marks. With a small number of students, the distinction between fossil and renewable was blurred.

Question 5
This was a ‘scenario’ question, which required students to assimilate a scenario and use their knowledge of terms and strategies to apply to the particular situation. Hence, responses which actually referred explicitly to the scenario, rather than focusing on definitions of terms (such as ‘ecosystem diversity’) were favoured in the marking.

Question 5a

Marks	**0**	**1**	**2**	**3**	**Average**
%	2	13	30	56	**2.41**

Some advantages included providing diverse habitats, wetlands forming sinks for some pollutants, traps removing litter etc. Some disadvantages included preventing species moving up and down the creek, changed habitat detrimental to some species etc. Those who did not achieve full marks generally failed to mention any disadvantage.

Question 5b

Marks	0	1	2	3	Average
%	4	11	30	55	2.36

Some of the main reasons for failing to score full marks included no reference whatsoever to the scenario (i.e. merely talking about wildlife corridors in general) or failing to refer to wildlife corridor, and focusing on advantages and disadvantages of the ponds themselves.

Question 5c

Marks	0	1	2	3	4	Average
%	9	14	26	30	21	2.42

Main reasons for failing to score full marks were not explaining or showing understanding of the terms 'ecosystem diversity' and species and genetic diversity; or failing to make any connection to the scenario. Ponds may assist ecosystem diversity by providing still water habitats in addition to flowing creek, etc.

Question 6

One of the outcomes listed in the study design is the 'use of scientific data in determining the protection measures of biodiversity treaties, agreements and regulatory frameworks', which was tested in Question 6. It was also intended to favour students who had done some actual analysis and simple estimation of significance in fieldwork, with either real or simulated data, an activity that the examiners would expect students to have undertaken.

Questions 6a

Marks	0	1	2	3	4	Average
%	8	2	3	4	83	3.54

Calculation of simple averages is one of the mathematical skills expected. Some working was required for full marks.

First year: 100 + 110 + 60 + 120 + 90 = 480. Average = $^{480}/_{5}$ = 96

Second year: 150 + 100 + 130 + 160 + 180 = 720. Average = $^{720}/_{5}$ = 144.

Question 6b

Marks	0	1	2	3	Average
%	42	18	17	23	1.20

Type I and Type II errors are mentioned in the study design. They were defined in the question, and the question tested ability to apply this to the data. If the scientist was in error it would have been falsely rejecting the null hypothesis (Type I), as she concluded that there was a significant difference; rather than Type II (falsely accepting the null hypothesis), that is had she concluded wrongly that there was no difference.

Question 6c

Marks	0	1	2	Average
%	20	32	48	1.28

The examiners were looking for: increase sample size, do counts on more days, using more sampling sections etc. Almost any intelligent suggestion was rewarded. A small number of students suggested making sure you did not count the same birds on successive days. (If there is a realistic way of doing this, considering one curlew sandpiper looks much like another, it would improve the data gathered.)

Questions 6d–g

The block of questions 6d–g tested use of an index (Jaccard's index). No knowledge of Jaccard's index was assumed; all necessary information was in the question. Given the widespread use of indices such as this in estimations of biodiversity, it would be hoped that students would have done a similar calculation and interpretation on some index in coursework.

This block was the last on the paper, and was deliberately intended to be a little more demanding and discriminating.

Question 6d

Marks	0	1	2	3	Average
%	19	24	32	25	**1.63**

Some of the responses expected by examiners included: because species protection requires action in more than one country, because suitable intermediate locations may be required along migratory routes, because monitoring needed in different countries to get complete picture, because international treaties tend to put pressure on countries to provide protection. Almost any intelligent comment was accepted, and a wide variety was presented by students. One student suggested that the birds could feel more confident setting out if they know they were protected at the other end.

Question 6e

Marks	0	1	2	Average
%	26	21	53	**1.27**

Number common to both sites 1 and 2 = 1 (Curlew sandpiper)

Total number of species = 7

Jaccard's index = $^{1}/_{7}$ or 0.14.

Question 6f

Marks	0	1	2	Average
%	26	20	54	**1.27**

Number common to both sites 1 and 3 = 2 (Curlew sandpiper, greenshank)

Total number of species = 5 (There are no Japanese snipe or sanderlings at either site 1 or 3)

Jaccard's index = $^{2}/_{5}$ or 0.4.

The most common error in Questions 6e and 6f was miscounting the total number of species, that is counting some twice. This mistake was penalised only once (that is, if made in both questions, 1 mark taken off in 6e, none in 6f.

Question 6g

Marks	0	1	2	Average
%	50	24	26	**0.75**

This question asked for an interpretation of the values for Jaccard's index, and, as intended, proved challenging and discriminating.

There is more commonality between sites 1 and 3 than between sites 1 and 2. This would have consequences for protection and conservation of sites. Both sites 1 and 2 deserve high protection. If one site has to be sacrificed, site 1 or 3, as it is somewhat duplicated in the other.

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