



Student Performance Q&A:

2007 AP[®] Environmental Science Free-Response Questions

The following comments on the 2007 free-response questions for AP[®] Environmental Science were compiled by the Chief Reader, Susan Postawko of the University of Oklahoma in Norman. They give an overview of each free-response question and of how students performed on the question, including typical student errors. General comments regarding the skills and content that students frequently have the most problems with are included. Some suggestions for improving student performance in these areas are also provided. Teachers are encouraged to attend a College Board workshop to learn strategies for improving student performance in specific areas.

Question 1

What was the intent of this question?

The intent of this document-based question was to determine the level of students' understanding of municipal wastewater treatment and the environmental effects associated with the disposal of the wastes from wastewater treatment plants. This question also asked students to identify one federal statute that relates to monitoring the quality of effluent discharge.

How well did students perform on this question?

Compared with the document-based questions on previous AP Environmental Science Exams, students performed very well, with a mean score of 4.93 out of a possible 10 points. Almost all of them attempted to answer this question, and many wrote several pages. Many students described either visiting a local wastewater treatment facility or referenced information gained from a guest speaker on sewage treatment.

What were common student errors or omissions?

Students often reversed the roles of primary and secondary treatment in part (a) or gave only a vague description of the treatment methods in part (b). Simply responding that chemicals were a component targeted for removal did not earn points in either part (a) or part (b). Some students had difficulty identifying an appropriate treatment process in part (b) for the specific pollutant identified in part (a). Most who did not receive a point in part (c) failed to identify a problem associated with the accumulation of solid waste at the treatment plant. In part (d) some students described general environmental problems associated with landfills but failed to relate these to the

disposal of solid waste from sewage treatment. On a positive note, many were able to describe in detail the eutrophic effects of nutrient-rich runoff from agricultural applications of solid sewage waste. Common errors in part (e) were incorrectly identifying an inorganic pollutant for treatment by disinfection or substituting disinfection methods appropriate for small quantities of drinking water for methods of disinfection used in sewage treatment.

Based on your experience of student responses at the AP Reading, what message would you like to send to teachers that might help them to improve the performance of their students on the exam?

- Students should be able to distinguish between the treatment of drinking water and the treatment of sewage wastewater, as well as have a rudimentary understanding of the laws that apply to both.
- Students need to engage in critical reading activities on a regular basis, utilizing case studies and news articles. A number of points could have been earned on this question by simply extracting the relevant information given in the document provided.

Question 2

What was the intent of this question?

The purpose of this data-based question was to assess students' ability to analyze information, to calculate water use and electricity costs, and to estimate the cost savings from replacing an old water heater with a more efficient one. It also measured students' ability to recognize home water conservation and energy conservation measures.

How well did students perform on this question?

Overall performance was good. The mean score was 5.76 out of a possible 10 points.

What were common student errors or omissions?

In parts (a) and (b) students often failed to show their work as specified and simply provided answers. Others incorrectly calculated answers or provided answers with incorrect units. In part (c) quite a few students did not differentiate between conservation in regard to total water use and using less hot water. Many were not specific enough in describing gray water and its uses to earn credit for conservation of water. In part (d) a lot of students chose *alternative energy sources* instead of *conservation measures*. Others discussed energy conservation methods for reducing hot water use, although the question asked for measures "other than reducing hot water use." Many students were not specific enough in describing how the use of passive solar energy would reduce the total amount of energy needed.

Based on your experience of student responses at the AP Reading, what message would you like to send to teachers that might help them to improve the performance of their students on the exam?

- Work with students on analyzing data, dimensional analysis, and the application of quantitative analysis to environmental problems.

- Where calculations are required, students should clearly show all of the steps in how they arrived at an answer.
- Many students' answers were badly organized; often they intermingled bits and pieces of several answers, without identifying or grouping the pieces. All work on the exam should be clearly identified and labeled.
- Students should be familiar with the economic costs associated with common resource use, like a utility bill, and should use that knowledge to evaluate the validity of their calculations (to a reasonable order of magnitude). They should know that \$7,300,000 is not a reasonable monthly electric bill for a family of four.

Question 3

What was the intent of this question?

This question was designed to gauge students' understanding of stratospheric ozone depletion, the class of chemical compounds primarily responsible for the thinning, the mechanism by which ozone molecules are broken down in the stratosphere, and the major environmental consequence of ozone depletion. It also required students to make a clear distinction between the problem of stratospheric ozone depletion and the presence of ground-level ozone, with the intent of assessing their ability to separate these two issues and the respective environmental consequences. The question also evaluated the ability of students to separate the problem of stratospheric ozone depletion and its consequences from two other major problems: global warming and acid deposition.

How well did students perform on this question?

Students performed moderately well, with a mean of 3.09 out of a possible 10 points. Most who attempted to answer part (a) were able to identify chlorofluorocarbons (CFCs) as the major class of chemicals responsible for thinning of the ozone layer and to describe at least one of the uses for which CFCs were manufactured. In part (c) many students were able to identify the major environmental consequence and describe one or two effects on ecosystems and/or human health. A number of others earned 2 points in part (d) for correctly describing an effect of ground-level ozone on human health and/or individual plants.

What were common student errors or omissions?

Many students either did not attempt to answer the question or attempted it but received no points. Some mistakenly named "greenhouse" gases as the chemicals responsible for thinning of the ozone layer; these students often continued this thread through parts (b) and (c) and as a result did poorly on the entire question. In part (b) many students did not correctly describe the role of ultraviolet radiation in freeing chlorine from CFCs and, owing to this common misconception, did not earn points for this part of the question. In part (d) few students received points for describing tropospheric ozone as a "greenhouse" gas leading to global warming, because they did not specify how such global warming would affect the ecosystem.

Based on your experience of student responses at the AP Reading, what message would you like to send to teachers that might help them to improve the performance of their students on the exam?

- Students must understand the basic science involved in important environmental processes like stratospheric ozone depletion. Without a sound, scientific understanding of the problem—in this case chemistry—students will not be able to adequately address the “how” parts of questions like this one on ozone depletion.
- Work with students on reading questions carefully and noting where linkage is specified within and between question parts. When students miss this subtlety, they may earn no points on one or more parts of a question.
- Help students to establish the boundaries between closely related and/or often confused environmental problems, and in each case, be sure they can link consequence(s) with effect(s). This is especially important for different issues that occur in the same “sphere” of the earth.
- Teachers should be careful in their use of “catchy” examples in teaching important concepts like stratospheric ozone depletion (e.g., CFCs act like little “Pac-Men” in consuming ozone molecules), as students may in turn use these examples on their exams and earn no points.
- Continue to work on getting students to understand the difference between the terms “identify” and “describe.”
- Continue to stress that when a question asks for two responses (examples), students should make sure the first two they include are the ones they want scored, as Exam Readers will give credit only for the first two—even if both of these are wrong and later items are correct. Students can cross out work they do not want scored, if they think of better examples.

Question 4

What was the intent of this question?

The aim of this question was to assess knowledge of contemporary environmental issues related to urban and rural areas. Students were required to describe differences in temperature, pollution, and the hydrologic cycle between the two areas. Additionally, they were asked to name actions that local governments could take to reduce urban outdoor air pollution.

How well did students perform on this question?

Most students attempted each part of the question and were generally focused on the topic. The mean score was 3.94 out of a possible 10 points. In part (a) the majority correctly indicated that urban areas had a higher temperature, which was associated with the urban heat island effect. In part (b) most students earned points for noting differences in the temperature between urban and rural areas.

What were common student errors or omissions?

Descriptions of the differences between urban and rural areas were often too vague to earn points. A common fallacy was that carbon dioxide is a local contributor to increased urban temperature rather than a global greenhouse gas. When students provided more than two possible differences, only the first two were scored. In part (c) many answers were vague and did not describe appropriate examples of specific pollutants and their origins. There also were misconceptions about thermal inversions. Thermal inversions are not a result of the urban microclimate, but rather a geographical effect, extending over regions instead of municipalities. In part (d) responses regarding local government actions were often nebulous or not supported with an appropriate outcome. Again, only the first two examples were scored. Some students focused on national legislation, such as the Clean Air Act, rather than local actions. In part (e) many apparently did not understand the term “hydrologic cycle.” Some incorrectly identified water quality and acid rain as major parts of the hydrologic cycle.

Based on your experience of student responses at the AP Reading, what message would you like to send to teachers that might help them to improve the performance of their students on the exam?

- Students should provide only the specific number of responses asked for in the question. A long list of possible answers does not enhance students' chances of success on the question. Rather, they should concentrate on supporting their assertions.
- Students should answer the question asked and be sure their answers are specific.