CollegeBoard
Advanced Placement Program

Student Performance Q&A:

2004 AP® Environmental Science Free-Response Questions

The following comments on the 2004 free-response questions for AP® Environmental Science were written 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?

One primary goal of this document-based question was to test students' ability to answer questions based on a reading. The topic of mercury emissions from coal-burning plants and its remediation is not generally covered in detail in student texts, so students' knowledge of current events and their ability to apply what they know about other pollutants to a new situation were also tested.

How well did students perform on this question?

Students did quite well on this question. The mean score was 4.1 out of 10 possible points. Students were able to identify the source of mercury and adequately discuss the transport and deposition of mercury. Even if a student had not specifically studied mercury, it was possible to earn up to six points in Parts (c) and (d.) Most students were able to discuss the general concept of biomagnification (bioaccumulation) as it related to the question. Almost all were able to identify another toxic metal, describe a correct mechanism for release of the metal into the environment, and describe a human health effect.

What were common student errors or omissions?

In Part (a) students often failed to identify coal as the fossil fuel whose burning releases mercury. The "burning of fossil fuel" was not enough to earn a point, because refined petroleum products and natural gas are not significant sources of mercury. Many students incorrectly identified the source of mercury as vehicle emissions, solid wastes from factories, or thermometers. Very few students earned the elaboration point in this part.

In Part (b) very few students earned points for correctly describing technologies that could lower the amount of mercury released into the environment, frequently describing sulfur dioxide removal techniques. The most common answers given involved the use of alternative energy sources or legislative incentives, though students often failed to "describe" how these would reduce the amount of mercury and therefore did not earn the point.

In Part (c) most students earned a point either for the concept of food chains/trophic levels or for the "large/long-lived" concept, but very few earned both points. Even fewer displayed any knowledge of the specifics of mercury absorption, storage, and concentration in organisms; therefore few received the elaboration point for this part.

In Part (d) the most common error was failure to identify a toxic metal. Common incorrect answers were radon, sulfur, or CFCs. Occasionally students described a health effect as "lethal" or provided an answer that was too vague, such as "lead poisoning" or "cancer."

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 need to be exposed to more document-based questions in preparation for the AP Exam. They would benefit from an increased focus on critical-reading skills that emphasize the analysis of material presented. Responses to the questions need to be related back to the document presented, when appropriate. Point/counterpoint debates about current environmental concerns might also be helpful.

Students should be reminded that a description involves more than just naming something. Naming a concept (e.g., "finding an alternative energy source") with a phrase or even a sentence may not constitute an adequate description, even though it is more than one word. Some students provided only general statements and failed to fully describe their ideas. They should be reminded that specific examples strengthen a description/discussion/argument and may mean the difference between earning and not earning a point.

Teachers are to be congratulated for doing a good job of teaching students about biomagnification/bioaccumulation. It was on that topic—as well as with the information on lead, its sources in the environment, and its health effects—that students earned the bulk of their points on this question.

Question 2

What was the intent of this question?

This question required students to integrate many aspects of interdisciplinary learning. The purpose of the question was to assess their ability to (1) manipulate data and solve equations, (2) use that data to determine the feasibility of developing alternative methods of energy generation, and (3) develop an environmental cost-benefit analysis.

How well did students perform on this question?

Student performance on this question was fair. The mean score was 2.7 out of 10 possible points. There were many math-related errors. Students who attempted Parts (a) and (b) and were moderately proficient in their calculations usually had a good overall score. The performance in

Part (c) indicated that, while many students have a basic understanding of energy laws, they have only a marginal understanding of the application of those laws. Part (d) was the most problematic section of the question. It was necessary for students to choose the information that would be the basis of their calculations, and many students were not able to identify which data were needed. In Part (e) many students identified valid benefits or costs but did not explain how they affected the environment, or they chose economic benefits and costs rather than environmental ones.

What were common student errors or omissions?

Common mistakes in Parts (a) and (b) included (1) not showing the calculation, (2) not converting from MW to kW, and (3) calculation mistakes, like errors with the number of zeros (e.g., 12,000 kW × 8,000 hr/yr = 96,000 kWh/yr).

In Part (c) students often failed to see a valid difference between the answers from Parts (a) and (b) because of basic math errors in those parts. Many students showed limited understanding of the theory and practice of power generation.

Part (d) required students to integrate information from the question and from their calculations in Parts (a) and (b). Many students had difficulty choosing the appropriate information with which to do the calculations. The most common mistakes in this section were calculation errors similar to those found in Parts (a) and (b). Some students did not earn full credit because they expressed their answer as 0.05 cents per kilowatt-hour rather than 0.05 dollars per kilowatt-hour.

In Part (e) common mistakes for benefits and costs included stating but not explaining the benefit or cost, using terms like "habitat loss" or "loss of biodiversity" without explanation, and using general terms like "air pollution" rather than identifying and explaining the effects of a specific pollutant. Many students did not earn points in Part (e) because they identified economic benefits and costs rather than environmental benefits and costs, as the question required.

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?

Teachers should emphasize course work that incorporates the use of basic algebraic calculations, dimensional analysis, and scientific notation to help solve environmental problems. Students should practice doing problems involving basic arithmetic functions without a calculator.

Students should be reminded to show all the steps of their work. Correct answers without supporting calculations earn no credit. Teachers should also encourage students to use units in their calculations to help them check their own work. Finally, students must understand that directions like "identify and describe" require that they give supporting information as to why their identification is appropriate.

Question 3

What was the intent of this question?

The primary purpose of this question was to assess students' knowledge of nuclear waste, its disposal/storage, and its effect on human health.

How well did students perform on this question?

Overall, student performance was fair. The mean score was 3.7 out of 10 possible points.

What were common student errors or omissions?

In Part (a) many students were not able to identify the differences in properties between high-level and low-level radioactive waste. They sometimes provided examples of the two types of waste but not properties of the waste. Many students had the misconception that low-level waste is not dangerous. They also were not clear on the differences in the duration of storage between the two types of waste. Many students were unable to identify a specific isotope found in radioactive waste. Many identified an element but not an isotope.

In Part (b) some students interpreted the question to mean that they should justify Yucca Mountain as the choice for a disposal site, and they provided characteristics of it and not of an ideal location. Many students confused hazardous/toxic waste with radioactive waste. Many students did not understand deep geological storage and confused landfills with deep underground storage.

In Part (c) some students did not address the long-term aspect of the management of radioactive waste, and many did not understand the difference between temporary and long-term storage. Some did not discuss the feasibility of the identified option. Many students did not understand the concept of reprocessing radioactive waste. Many students did not read the question carefully enough to determine that it was asking for "other" management options.

In Part (d) some students did not describe how the adverse health effect is caused by exposure to ionizing radiation. They did not indicate how the radiation causes cellular or molecular damage. Many students provided a definition of cancer rather than the cause of the disease.

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?

When practical, students should be encouraged to consult original sources of information like government documents and Web sites. Teachers should encourage students to read questions carefully before beginning their answers, to correctly determine the information being requested.

Question 4

What was the intent of this question?

The primary purpose of this question was to test students' knowledge of soil properties and how to measure them and to test students' understanding of practices that are used to sustain soil resources. Finally, the question tested students' ability to identify the biomes that contain rich amounts of humus and to describe the benefits provided by humus.

How well did students perform on this question?

The mean score was 3.8 out of 10 possible points. This was largely a lab-based question, and students who had apparently not carried out soil tests in their AP course struggled with the question, even though the information needed to answer the question is contained in environmental science textbooks. Student descriptions of chemical tests were generally better than descriptions of physical tests; this suggests that students are more often taught the former.

Students showed good understanding of the benefits and disadvantages of using inorganic fertilizer, especially with regard to the relationship between agricultural runoff and eutrophication.

What were common student errors or omissions?

In Part (a) the majority of the students successfully described chemical tests, although with pH they often neglected to say what was actually being tested. The descriptions of physical tests were not as well done; students sometimes identified one physical test but described another. Explanations of how the results could be used in sustainable agriculture were often vague or omitted altogether. A number of students misinterpreted the question and provided an experimental design.

In Part (b) students frequently confused inorganic fertilizers with pesticides. Many did not explain how fertilizers are transported from the site of application into the environment through runoff or groundwater infiltration. A number of students used vague, qualifying terms like "better" or "healthier" rather than quantifiable terms. In general, however, students performed well on this part.

In Part (c) many students had difficulty recalling the proper names for conservation practices, so the points they earned were for the descriptions. Others named a practice without providing the required description. The link between agricultural practices and erosion was frequently omitted. Students who chose crop rotation had to describe how cover crops could be used to prevent erosion, but many discussed nutrients instead.

In Part (d) many students expressed the misconception that tropical moist forests are rich in humus. Other students confused biomes with habitats. Most students were able to list two ways humus helps plant growth but did not mention the role of decomposition in the formation of humus.

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?

Teachers are encouraged to have students perform soil labs and take field trips. County agricultural extension agents often provide printed material and may be willing to suggest appropriate farms to visit.