Student Performance Q&A:

2009 AP® Environmental Science Free-Response Questions

The following comments on the 2009 free-response questions for AP® Environmental Science were written by the Chief Reader, Art Samel of Bowling Green State University in Ohio. 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?

This was a document-based question based on a mock newspaper article. The article reported an apparent misconception about the role nitrogen plays in the environment. In addition to refuting the statement of the city councilman, students were asked to demonstrate their understanding of the role nitrogen plays in the environment and their knowledge of the formation and effects of photochemical smog.

How well did students perform on this question?

The mean score was 2.62 out of a possible 10 points. The issues addressed in this question are emphasized in the Topic Outline in the *AP Environmental Science Course Description* and in the textbooks most teachers use for the course.

What were common student errors or omissions?

In part (a) there were no notable common errors.

In part (b) few students correctly described the formation of a primary pollutant. Students often stated that the pollutant is formed "in cars," "in the atmosphere," or "in emissions," without demonstrating an understanding of the chemistry involved in its formation (i.e., N_2 reacts with O_2 in a high-temperature environment in internal combustion engines). The explanation of why the councilman was wrong often was not complete enough to earn a point. Rather than stating that nitrogen-containing fertilizers do not release the air pollutants that cause photochemical smog, many students wrote that fertilizers "release no air pollution," "stay in the ground," or "are not burned."

In part (c) many students did not identify a secondary pollutant that is a component of photochemical smog and, as a result, earned none of the 4 points available. Those students who did identify a secondary pollutant often did not describe its formation, but they did correctly identify a human health effect and an environmental effect.

In part (d) students often mislabeled the chemical transformation in the step of the nitrogen cycle they identified—for example, labeling nitrogen fixation as nitrification, or denitrification as ammonification. Although students were not held responsible for exact terminology and could still earn all points in this section despite errors in labeling, they were required to correctly describe the chemical transformation.

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?

- Provide students with substantial practice and preparation with major topics of study in AP Environmental Science, such as the nitrogen cycle and photochemical smog.

- Encourage students to read the exam questions carefully. For instance, when asked for a nitrogen-containing primary pollutant in part (b), students should not list carbon monoxide or carbon dioxide.

- Provide students with the means, support, and encouragement to review their knowledge of the relevant chemistry behind chemical transformations that happen in the environment both naturally and due to human activity.

- Ensure that students can identify the specific effects of human impacts on the environment.

- Emphasize *understanding* the mechanism and the significance of environmental change, not just the terminology. For example, it is more important for students to know the underlying chemical changes that occur during a step of the nitrogen cycle, and the significance of those changes to an ecosystem, than for them to know the name of the step.

Question 2

What was the intent of this question?

The intent of this question was for students to demonstrate an understanding of how fuel sources, such as methane, may be used to generate electricity and how harvesting methane from cow manure provides specific environmental benefits. Students were required to demonstrate their ability to use basic mathematical functions (multiplication and division) and set up equations to calculate the impact on electricity use of a methane digester on a farm where cattle are raised.

How well did students perform on this question?

The mean score was 3.66 out of a possible 10 points.

What were common student errors or omissions?

A common error in part (a) was lack of specificity in the answers. Students sometimes described a process of steam generation using methane gas, without indicating that methane must be burned to produce heat. Many students did not describe the process of electricity generation using steam-driven turbines.

In part (b) students often identified an environmental benefit, such as the reduction in fossil fuels used for electricity generation, without discussing any specific positive impacts of the benefit. The prompt's directions to "discuss" required more than identification to earn credit.

Common mistakes in part (c)(i) were miscalculations of the kWh/year. In part (c)(ii) a frequent error was misinterpretation of the question: instead of identifying the amount saved, students calculated (correctly) the cost of the electricity needed with the digester in operation. Another frequent mistake was incorrectly rounding numbers in parts (c)(ii), (c)(iii), and (d). It is not possible to have a fractional cow. A common mistake was truncating the number 730.5 cows to 730 instead of rounding to 731.

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?

- Teach students to give specific answers to the prompts. General terms, such as "air pollution," "emissions," and "water pollution," earn no credit.

- Remind students that when they are answering calculation questions, they must show *all* steps clearly, including intermediate steps, in order to receive credit. It is not advantageous to answer questions that require calculations by using only prose, unless students clearly state the mathematical functions they used to arrive at their answers.

- Tell students that answers set off with summary sentences, circles, or boxes are encouraged.

Question 3

What was the intent of this question?

This question tested students' knowledge of water resources, specifically the impacts and benefits of dams on rivers. The question also asked students to consider water-saving measures in agricultural production, to link climate-change phenomena to river hydrology, and finally to describe the linkage of climate change to hydrology and ecosystem dynamics in coastal areas.

How well did students perform on this question?

The mean score was 3.86 out of a possible 10 points.

What were common student errors or omissions?

Some students wrote that dams "create energy" or otherwise suggested processes that violated the laws of thermodynamics; correct responses had to refer to electrical production.

In part (c) numerous responses listed household or landscaping water-saving strategies rather than agricultural practices.

Most students correctly explained some ecological effects of dams (e.g., acting as a barrier to migratory fish) and benefits that dams provide to society. However, some responses confused the effects of the dam structure itself and inundation caused by the reservoir, or the effects of dams on stream scouring and sedimentation, or evaporative loss from a reservoir surface.

Several factual errors were common, including:

- Confusing the terms aquatic, freshwater, and marine
- Identifying a tsunami as a climatic/meteorological phenomenon (instead of a geological phenomenon)
- Suggesting "thermal pollution" is caused by global warming (rather than by industrial activity)
- Making spurious suggestions to "move" rivers or to "make" new rivers
- Confusing the ecology of organisms with hydrology
- Confusing riverbank and marine coastline
- Providing strategies to conserve soil rather than water, as specified

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?

Remind students to:

- Read the question carefully and then pause briefly to consider how many examples are needed in each part, how the parts of the question are similar or different, and other specifics.
- Write in prose. Too many responses failed to earn points because the answer was in outline form (bullets) instead of sentences.
- "Describe" or "discuss" when required; such instructions imply more detail than a mere identification of a term or example.
- Write responses that are targeted directly at the issue in the question: specific water-saving techniques, plausible ecological effects, an explanation of how air pollution is reduced by avoiding fossil-fuel combustion, and so on. Responding with buzzwords does not earn points.

Question 4

What was the intent of this question?

The question assessed students' knowledge of the environmental and economic implications of current agricultural practices for food production and distribution, focusing specifically on the environmental and economic implications of genetically modified crops. The question also tested students' abilities to interpret data and trends from a graph and to describe currrent farming practices that help maintain a healthy soil profile. The question also measured the ability to describe the environmental and economic benefits of eating locally grown produce.

How well did students perform on this question?

Overall performance was good, with a mean score of 4.41 out of a possible 10 points.

What were common student errors or omissions?

In part (a) students could have used calculations to obtain answers, or they could have simply interpreted the graph to extrapolate the answer. Many students did well on parts (a)(i), (a)(ii), and (a)(iii) and provided the correct units. In part (a)(iv) students often incorrectly provided answers that applied to all crops rather than an answer that was specific to genetically modified crops.

In parts (b) and (c) many students answered with very general vocabulary associated with genetically modified crops, without providing adequate descriptions. They often blended or confused the focal areas of environment and economy. This is a reminder that students benefit from practice with organizing their thoughts before writing a clear description.

In part (d) most students named at least one viable agricultural practice for maintaining or improving soil quality. Additionally, many students provided an adequate description or advantage of the practice(s).

In part (e) many students blended or confused the focal areas of environment and economy, or they provided an incomplete description of the advantageous nature of their answer.

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?

Encourage students to:

- Carefully consider the specifics of what each question is asking and organize their responses accordingly.
- Write about what they know best when a question asks for one description or one example, and remember that additional examples do not earn points.
- Make sure that descriptions or examples are not just noted but include a clear explanation that relates to the intent of the question.

- Show computational work where required and include units in their answers. Canceling the units in their work as they compute the answer will help students ensure that the final answer is correct.
- Practice with quantitative analysis of environmental problems.