



Student Performance Q&A: 2013 AP[®] Environmental Science Free-Response Questions

The following comments on the 2013 free-response questions for AP[®] Environmental Science were written by the Chief Reader, Art Samel of Bowling Green State University, 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?

The intent of this question was for students to demonstrate knowledge of how humans have impacted the coastal ecosystem of the Gulf of Mexico. Students were first asked to describe two specific activities that have altered the flow of sediment and then were asked to describe how fertilizer runoff has contributed to cultural eutrophication in the Gulf. Additionally, students were asked to demonstrate a basic knowledge of wetland ecosystems and the impact of cultural eutrophication on the economy of this region. The last task was to identify a strategy to reduce the flow of nutrients into the Gulf.

How well did students perform on this question?

The mean score was 4.65 out of a possible 10 points.

What were common student errors or omissions?

Common student errors in part (a) included a lack of knowledge of what human activities alter sediment loads in the Mississippi River. Although students could identify a human activity, many were not able to provide an appropriate explanation linked to their identification. Common errors were the idea that sediments can get stuck to boats and ships or that throwing litter/waste into the river would cause blockages that prevented sediment from traveling to the Gulf. To earn points, a student had to state whether the activity increased or decreased the sediment load to the Gulf, but many students repeated the question stem without indicating that they understood this distinction of whether the identified activity increased or decreased the load. In part (b), students confused the impacts of sediments and nutrients on aquatic systems. In part (c)(i), students often confused fertilizers with toxins and sometimes described biomagnification and bioaccumulation as environmental impacts of fertilizer runoff instead of giving a description of cultural eutrophication. In part (c)(ii), a common error was the idea that money would have to be spent by farmers upstream in order to reapply fertilizer to their fields. In (c)(iii), a common misconception was that soluble nutrients such as nitrates could be filtered out of the water using a mechanical technique such as a screen.

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 use specific language and examples in their answers to questions. If a question asks what alters the flow of sediment, students should state a direction (increase or decrease). Students should avoid using terms such as “habitat” and “pollution” without clear examples. Responses that used vague vocabulary did not earn points, for example, stating that “money must be spent to fix the problem,” does not demonstrate knowledge of the problem of nutrients in the Gulf. Spend time helping students distinguish between different types of aquatic pollution, such as sediment and nutrients.

Question 2

What was the intent of this question?

- (a) The intent of part (a) was to ask students to identify viable strategies the federal government could implement to encourage the use of battery electric vehicles (BEVs).
- (b) The intent of part (b) was to ask students to perform calculations relating to the cost of gasoline needed to operate an internal combustion engine (ICE) vehicle.
- (c) The intent of part (c) was to ask students to perform mathematical calculations and dimensional analyses relating to the cost of electricity needed to operate a BEV.
- (d) The intent of part (d) was to ask students to perform mathematical calculations relating to the amount of CO₂ produced by BEVs compared to ICE vehicles.
- (e) The intent of part (e) was to ask students to describe economic impacts of an increased use of BEVs.

How well did students perform on this question?

The mean score was 4.27 out of a possible 10 points.

What were common student errors or omissions?

In part (a), students did relatively well. However, many students simply indicated that the government could directly increase the price of ICE vehicles and/or gasoline (or decrease the price of BEVs and/or electricity), rather than explaining that the government could manipulate the prices through taxes and/or subsidies. Also, rather than responding to the question, many students described reasons **why** the federal government should encourage the use of BEVs (e.g., they produce less carbon dioxide, they are more environmentally friendly, etc.). Some students used “flipsides of the same coin” as two different strategies and earned only one point (e.g., “increase tax on the purchase of ICE vehicles, and decrease tax on the purchase of BEV vehicles.”). Some students answered with incomplete thoughts and did not earn points (e.g., “Commercials, taxes, and rebates.”).

- (a) Many students incorrectly converted their calculated answers to cents instead of dollars, reporting their answer as “0.15 cents” or “0.15¢”. Some students used “gallons” in one part of the setup but not the other (“\$3.75 divided by 25 mpg”). Some students reported incorrect units in their answer (e.g., “\$0.15 per gallon”).
- (b) (i) Many students failed to earn the setup point in (i) because they did not correctly report all units in the setup. Many students set up the equation correctly but committed multiplication errors. Many students incorrectly converted their setup to long division, switching the two numbers in the calculation. Many students gave a correct answer but did not earn a point because they showed no

work. Many students completely skipped (c) and (d), with some indicating that they “don’t do math.”

(ii) Many students who answered (i) failed to earn a point in (ii) because either they multiplied by 100 rather than divide or they divided by 100 incorrectly. Also, some students incorrectly reported an answer of \$0.038 instead of \$0.0308, and some students incorrectly rounded to \$0.032.

(c) The majority of students failed to earn the point in (d) because either they were unable to perform the addition and subtraction necessary to answer the question, or they performed the calculations correctly but failed to report units (lb) in their answer.

(d) The most common errors committed in this part of the question involved students identifying impacts that were environmental and political, but not economic (e.g., less harmful to ecosystems; less need for foreign oil; fewer illnesses from exposure to pollution, with no mention of health care costs; increased need for coal, with no mention of growth in the coal industry; increased need for charging stations, with no mention of expenses necessary to build such infrastructure). Some students also demonstrated a lack of understanding of the law of supply and demand by saying such things as “the price of a BEV will decrease because everybody will want one.” Some students gave answers relating to CO₂ and the price of gasoline, even though such answers are forbidden by the question.

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 consider the following suggestions

- Encourage students to read questions carefully and answer in complete sentences.
- Help students understand alternative transportation technologies and hurdles to their use (e.g., lack of charging stations for BEVs).
- Help students understand the role of the federal government in environmental policy (versus state and local governments) and in economics (the government does not directly control prices of commodities and electricity).
- Help students to understand the basics of economics (e.g., what economics is, law of supply and demand, etc.) and answer accordingly when prompted in a question.
- Teach students how to perform dimensional analysis (including all units in the setup) and how to do simple calculations without a calculator.
- Emphasize how to work with scientific notation and exponents.
- Instruct students to show all necessary work and calculations, and to show it within the space provided in the question, rather than using the inside cover or the first page of the test booklet.

Question 3

What was the intent of this question?

The intent of this question was to have students demonstrate their understanding of the different roles ozone plays in the Earth's atmosphere. Students were asked about the formation of both stratospheric and tropospheric ozone, the natural and anthropogenic destruction of stratospheric ozone, and the impacts that the ozone in both layers of the atmosphere has on life on Earth.

How well did students perform on this question?

The mean score was 3.78 out of a possible 10 points.

What were common student errors or omissions?

In part (a) there were no common errors, and most students correctly identified ultraviolet radiation as the radiation absorbed in the stratosphere as well as a health benefit resulting from the absorption of UV radiation in the stratosphere.

In part (b), most students did not correctly describe the chemical processes that decompose and form ozone in the stratosphere. Students earned credit for a description of the decomposition reaction than for a description the formation reaction.

In part (c), most students did not correctly explain the processes by which CFCs lead to the destruction of stratospheric ozone. Of the students who earned points in (i), most earned 1 point for explaining that chlorine atoms released by CFCs are responsible for breaking down ozone molecules; however, few students earned a second point for explaining that those chlorine atoms are only released by CFCs when they absorb UV radiation. In part (ii), most of the students who earned a point in part (i) also earned this point for explaining why stratospheric ozone depletion is slow to decrease.

In part (d) most students identified a correct human activity; however, few students earned a point for linking tropospheric ozone formation with sunlight during the daytime. Many students incorrectly stated that increased human activity during the day explains ozone formation, failing to mention that sunlight is required for the photochemical reactions that lead to ozone formation.

In part (e) many students earned a point for a correct negative human health impact of tropospheric ozone, and did not earn the point for a negative ecological impact.

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 consider the following suggestions:

- Be familiar with the chemical underpinnings of major topics in environmental science. The chemical reactions that describe ozone formation and destruction in the stratosphere and ozone formation in the troposphere are examples of the type of chemistry with which AP[®] Environmental Science students should be familiar.
- Remind students that when writing about the ecological impact of an activity, answers should convey, as specifically as possible, how the activity directly affects the population or distribution of a non-human living organism.
- Remind students to read each prompt carefully. It is important that the words “ecological” and “economic” are not confused with one another.

- Remind students to respond appropriately to each prompt. When “one” or “a” piece of information is requested, only the first relevant item in their answer may earn the point(s) for a correct answer. Likewise, when two pieces of information are requested, only the first two relevant items may earn points.

Question 4

What was the intent of this question?

The intent of this question was to ascertain students’ knowledge of biodiversity. Students were initially asked to describe two characteristics shared by systems with high biodiversity and later they were asked to describe two benefits of that greater biodiversity. Students were also asked to identify and explain two human activities that lower biodiversity and to propose a practical solution to each activity. Additionally, students were asked to describe one natural occurring factor that lowers biodiversity.

How well did students perform on this question?

The mean score was 4.06 out of a possible 10 points.

What were common student errors or omissions?

In part (a), many students identified characteristics shared by ecosystems with high biodiversity rather than describing those characteristics.

Students performed well in part (b). Students were able to identify and explain at least one specific human activity that would result in a loss of biodiversity.

In part (c), students did not connect their solution to the problem or activity described in part (b).

In part (d), students identified, rather than described, a naturally occurring factor that could lead to a loss of biodiversity.

In part (e), students frequently gave answers that would be more appropriate for part (a).

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 consider the following suggestions:

- Remind students that biodiversity refers to genetic and ecosystems diversity as well as species diversity.
- Many students had difficulty describing the characteristics shared by ecosystems with high biodiversity. Rather than simply giving examples of systems with high biodiversity, teachers should explain or describe how those characteristics lead to greater biodiversity and the benefits associated with greater biodiversity.
- Remind students to respond appropriately to each prompt. When asked to describe something, they should write the most complete description they are capable of writing. If they simply identify something, use a buzzword, or write an incomplete description, they will not earn a point for a description.
- Have students research and propose practical solutions to environmental issues.
- Encourage students to differentiate between ecological, economic, and societal benefits.