

Student Performance Q&A: 2011 AP[®] Environmental Science Free-Response Questions

The following comments on the 2011 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 question was based on a mock newspaper article. The article described population changes in two species of insects, mountain pine beetles and European honeybees. Students were asked to explain how fire-suppression policies in forests encourage beetle populations, to describe how beetle activity enhances climate change, to identify what physical changes occur with the death of mature trees, and to describe how those changes affect the forest. The second part of the question required students to describe the economic consequences of colony collapse disorder (CCD) in honeybees and to identify an ecosystem service other than pollination and explain how it benefits society.

How well did students perform on this question?

The mean score was 4.98 out of a possible 10 points.

What were common student errors or omissions?

In part (a)(i) a common mistake was indicating that fire is a significant control mechanism of beetle populations and so lack of fire in forests owing to fire-suppression policies has allowed increased beetle activity. Fire-suppression policies have made forests more vulnerable because forests are denser and contain trees that are all mature, which are the preferred target of the mountain pine beetle.

In part (a)(ii) some students did not identify the impact of deforestation on the carbon cycle. Students who were able to provide one correct answer often did not earn a second point because they were unable to identify a second way in which beetle activity enhanced climate change. Many students gave answers that were appropriate for part (b) or repeated their first response.

In part (b) students often neglected to identify a valid physical change that results from forest loss. Some students were able to provide impacts, which could be physical, chemical or biological, but if they did not link them to the physical change, they did not earn credit. A common mistake was the use of the word “home” in a physical change (loss of homes, homes destroyed). This language was too anthropomorphic and did not earn credit.

In part (c) some students did not clearly state an economic consequence of colony collapse disorder (CCD), used language that was too vague, or did not clearly tie supply and demand into their explanation.

In part (d) a common mistake was not linking an ecosystem service to a human benefit. Many students who earned a point for the ecosystem service neglected to link it clearly to how that service benefits humans. Many gave explanations of how the service worked and how it benefited organisms without following through to how it benefited human society.

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 to express their thoughts in complete sentences.
- Students should avoid language such as “homes” when describing habitats and need to do more than restate the question in their responses. For example, “loss of trees” is not an acceptable description of a physical change because the question states “the widespread death of trees.”
- Students should directly link their descriptions to their identifications.
- As much as possible students should use clear language. For example, in part (c) phrases such as “the economy is hurt” were too vague and did not demonstrate the student’s understanding of how a lack of supply leads to higher prices. Responses that showed an obvious indication of how prices and revenue increased or decreased earned credit.
- Students should organize their thoughts before they write their responses and present only as many reasons as requested in the question. More complete responses that offered accurate information were more likely to earn points compared to responses with less explanation. If questions ask for TWO reasons, students should state two and not add a third answer at the end. It is helpful if students are clear as to which part of the question they are answering by labeling their answers and stating, “The first physical change is ... ,” “The second physical change is”

Question 2

What was the intent of this question?

The intent of this question was to assess students’ knowledge about ocean acidification and its effects on coral reefs. Students were also asked to perform a series of calculations about the dimensions of coral reefs and to identify another problem affecting marine ecosystems.

How well did students perform on this question?

The mean score was 3.23 out of a possible 10 points.

What were common student errors or omissions?

In part (a) most students did not explain that carbon dioxide and water react to form an acid (carbonic acid). Many students repeated the question (stating that carbon dioxide lowers the pH of water) or added only an indication of knowledge of the pH scale (stating that carbon dioxide makes ocean water more acidic) without indicating the formation of an acid.

In part (b) some students did not demonstrate the understanding that carbon dioxide enters the ocean from the atmosphere, or they did not specify the combustion of fossil fuels as the source of increased atmospheric carbon dioxide.

In part (c)(i) many students who attempted the calculation did not correctly convert the growth rate of corals from millimeters to meters. In part (c)(iii) some students incorrectly interpreted the question and calculated 80 percent of total coral mass rather than 20 percent.

In part (d) many students omitted a description of their identified impact or, rather than a description, provided a consequence of the impact, or a second impact.

In part (e) some students did not provide a specific problem but instead provided a general class of problems (e.g., pollution or water pollution).

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 learn the scientific principles that underlie environmental processes and change. In this question, for example, many students did not indicate an understanding of the basic chemistry involved in ocean acidification (the reaction between water and carbon dioxide to form carbonic acid).
- Remind students to write precisely when responding to questions. Write, for example, that the “combustion or burning of fossil fuels adds carbon dioxide to the atmosphere,” rather than “fossil fuel use produces carbon dioxide.” Without any indication of how fossil fuels are used or where the carbon dioxide ends up, the second statement was too vague to earn points based on the scoring guidelines for the exam.
- Encourage students to practice carrying out calculations using scientific notation. Provide sample calculations, use worksheets, and, if necessary, teach or reteach students how to perform basic arithmetic using scientific notation.
- Encourage students to attempt each part of a multipart calculation. Often students can earn points in subsequent steps even if they do not correctly perform the initial step of a calculation.
- Continue to encourage students to include the units in the setup of their calculations.
- Students should be comfortable working with percentages without relying on a calculator.
- Remind students to read each part of the question carefully. When asked to identify and describe, for example, students will only earn points if they include a description that corresponds with the identified factor. Responses that provide a consequence or identify additional factors will not earn points.

- Instruct students to avoid responding with general categories when asked to provide information. Pollution, water pollution, waste, runoff and so forth do not demonstrate the level of understanding expected of a student who has completed a college-level course in environmental science. More specific information, such as phosphate or nitrate runoff, mercury pollution, and human waste or sewage, demonstrates a deeper understanding of, in this case, a few of the problems that affect marine ecosystems globally.

Question 3

What was the intent of this question?

The intent of this question was to have students demonstrate their understanding of energy resources and consequences associated with the use of those resources. Topics included describing how geothermal energy could be used to generate electricity, air pollution issues related to the generation of electricity, and the use of either sugarcane or tar sands, nontraditional energy resources.

How well did students perform on this question?

The mean score was 2.38 out a possible 10 points.

What were common student errors or omissions?

In part (a) students understood that steam was used to power a turbine, but many did not identify how the steam was harnessed. Had students known the general scheme for production of electricity from a fossil fuel, they would have earned at least 1 point in part (a). Additionally, instead of describing how a geothermal source could be used to generate electricity, many students described how a geothermal heat pump operated.

In part (b) most students demonstrated an understanding of the difference between per capita and the total population, although some students attributed China's CO₂ emissions to respiration by the large population.

In part (c) many students did not earn points because of vague answers. Many students identified smog as an issue rather than identifying the component of smog that affects human health. Lung cancer was also cited as the health impact for a variety of pollutants, none of which are known to cause lung cancer.

In part (d)(i) many students knew that a fermentation process was necessary to produce ethanol; however, few knew how the sucrose (sugar) was removed from the sugarcane. Most students did not know how tar sands are mined or processed. In part (d)(ii) many students did not earn points because of vague answers. For example, some said too much land would have to be used but did not explain why it was a disadvantage.

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?

- Spend time with students discussing traditional and alternate energy resources, including pros and cons of each of those sources.
- Review the criteria for air pollutants, their sources and their impacts on human health.

- Remind students to read the question carefully, not merely restate the question as their answer, and to answer the question that is asked. For example, if asked how geothermal energy is used to create electricity, students should not answer by describing a geothermal heat pump.
- Remind students to fully describe, discuss or explain their answers where they are prompted to do so.
- Avoid using watered-down vocabulary in class. For example, students should know that ethanol is produced via fermentation and distillation, not just that ethanol is produced by a process.

Question 4

What was the intent of this question?

The intent of this question was to have students demonstrate their ability to graph and interpret data and to demonstrate their knowledge of soil properties, agricultural strategies that can be used to reduce the need for arable land, and the process of soil salinization.

How well did students perform on this question?

The mean score was 5.34 out of a possible 10 points.

What were common student errors or omissions?

In part (a) students often plotted their data points incorrectly. The most common error was to plot the 1900 point below the midway point between the 0.25 billion hectare line and the 0.5 billion hectare line, or to plot the 1940 line above the midway point between the 0.5 billion hectare line and the 0.75 billion hectare line, whereas the correct placement for those points should be above and below the midpoints, respectively. Students were not penalized for plotting their points exactly on the midpoints. Also, because the gridlines were provided, a point was not earned if the 1980, 2020 or 2060 points did not touch the appropriate grid intersection. Another common error was to use straight lines to connect the points, rather than a smooth curve.

In part (b) the most common error was to misinterpret the 2050 line as being 2040 and answer accordingly.

In part (c) the most common error was for students to identify nutrient content as a soil property without identifying a specific nutrient. Also, many students identified a soil property and then simply defined the term rather than describe how the property relates to soil quality or, if they did attempt to describe, did not do so clearly or completely.

In part (d) one common mistake was for students to inadequately describe a viable strategy. For example, some students identified decreasing human populations as a strategy, but such an answer is inadequate without an explanation as to how to go about doing so (i.e., how to make it “viable”). Similarly, some students identified a valid strategy but did not clearly link the strategy back to the problem. Some students identified a strategy of planting high-yield crops without explaining how high yield would be achieved (e.g., artificially selecting for crops that can be grown closer together). Many students also identified a strategy of simply growing two crops close together, but such answers only garnered a point if a student indicated that the crops need to be noncompetitive. Another common error was to identify a strategy for converting new lands to agriculture (e.g., by terracing), but the question specifically asked students to identify strategies to

reduce the amount of land needed. Because overharvesting of our oceans is already occurring, students did not earn a point for indicating that humans can rely more on seafood unless they specifically indicated that the food would be farmed or raised via aquaculture.

In part (e)(i) the main problem was that students would often skip a step in the salinization process by omitting any mention of water evaporating or being used by plants, or if they did not skip the step, they did not identify the source of the water (e.g., irrigation). Students also often confused salinization with acidification.

In part (e)(ii) there were no common errors. Most students who knew what causes salinization were readily able to explain how to prevent or remediate salinization.

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?

- Instruct students to use the graph axes or grid provided on the exam, as some students drew their graphs from scratch.
- Instruct students to plot their data carefully.
- Instruct students that their responses should be specific and provide sufficient detail to demonstrate understanding. Students need to avoid using vague language like “nutrients” altogether or give specific examples when they seem warranted.
- Students need to pay attention to whether a question asks them to “identify” or “describe.” If a question asks them to “describe,” then they need to describe and not just identify.
- In their description of a process, students need to be sure not to skip any steps. They also need to make sure that they clearly link their answers to what is being asked.