

2022

AP<sup>®</sup>

 CollegeBoard

---

# AP<sup>®</sup> Environmental Science

## Free-Response Questions Set 1

ENVIRONMENTAL SCIENCE

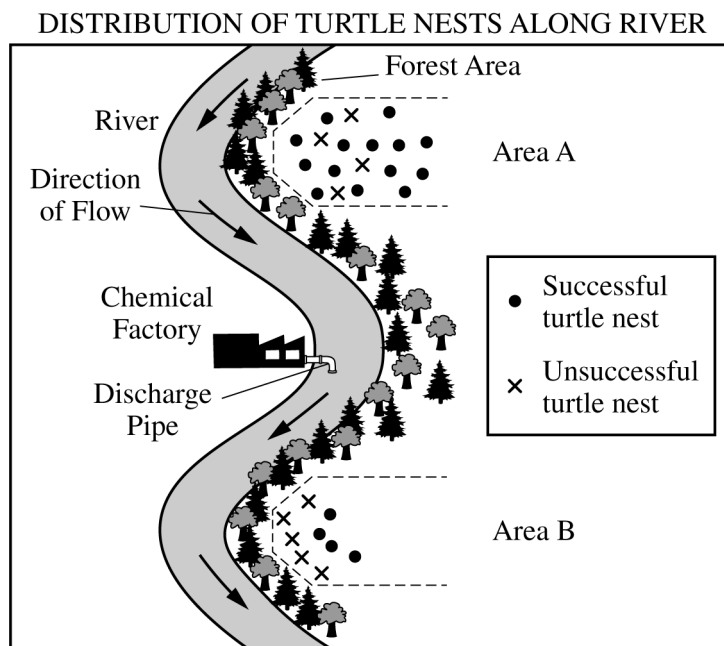
SECTION II

Time—1 hour and 10 minutes

3 Questions

**Directions:** Answer all three questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers in the Free Response booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples. You may plan your answers in this orange booklet, but no credit will be given for anything written in this booklet. **You will only earn credit for what you write in the separate Free Response booklet.**

- Common snapping turtles, *Chelydra serpentina*, are primarily aquatic, but they lay their eggs on land. Researchers are interested in understanding the impact of pollution on turtle nesting sites. The researchers examined nesting sites at two agricultural areas along the floodplain of a river upstream and downstream from a chemical factory that is a known source of aqueous mercury pollution. Turtle eggs, soil, and vegetation samples taken from areas around turtle nests downstream from the chemical factory showed high levels of mercury in a previous study. Mercury was not detected in samples taken upstream from the chemical factory.

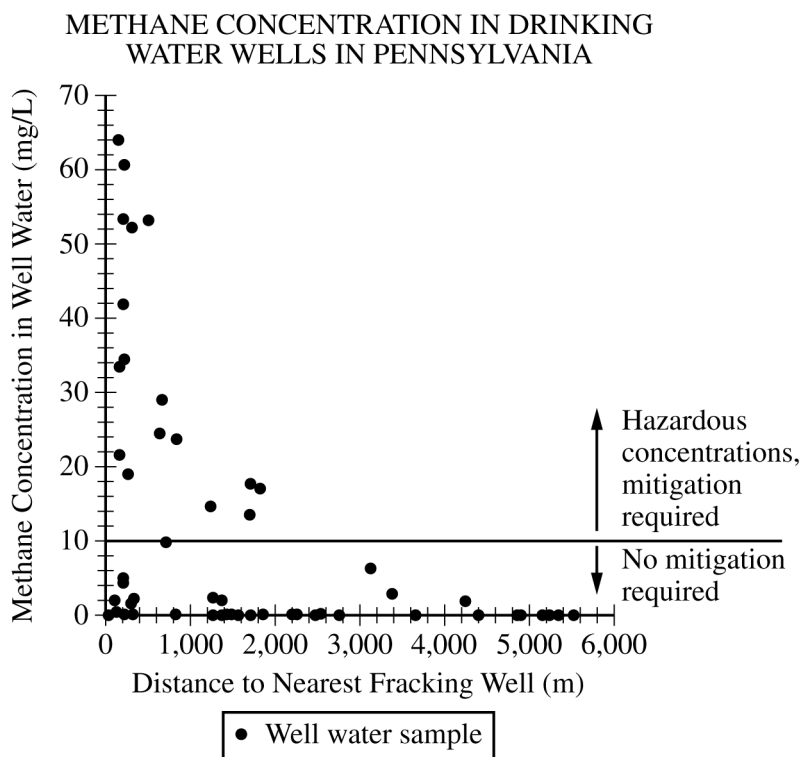


- (a) The map shows locations of both successful and unsuccessful turtle nests.
- (i) **Identify** the area with the greatest nest success rate, based on the information in the diagram.
  - (ii) **Identify** the dependent variable in the study.
  - (iii) Based on the information provided, **identify** a likely scientific question for the study.
  - (iv) **Describe** why researchers measured mercury levels in locations upstream from the factory.
  - (v) There are plans to remove trees and other vegetation along the river bank. **Explain** how this modification could affect the location and number of successful turtle nests in Area B.
- (b) Mercury can affect organisms and ecosystems in many ways.
- (i) **Describe** how a persistent pollutant, such as mercury, can negatively affect an organism.
  - (ii) **Describe** how a persistent pollutant, such as mercury, can negatively affect an ecosystem.
  - (iii) Researchers measured methylmercury in a location downstream from the factory. **Explain** how methylmercury could be present in the stream.
  - (iv) Researchers claimed that the soil nearest to the river has higher levels of mercury than the field has, and those elevated levels have affected the nesting success for turtles. **Explain** how the pattern shown in the diagram supports or refutes this claim.
- (c) The turtle study was conducted in an agricultural area. **Describe** how a specific agricultural practice changes the soil in an area.

---

**Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.**

2. Developments in advanced hydraulic fracturing (fracking) technologies have allowed the total oil and gas production in the United States to increase rapidly.



- (a) The graph shows the methane concentration in drinking water from home wells and the distance to the nearest fracking well in Pennsylvania.
- Based on the data in the graph, **identify** the highest methane concentration found in well water in Pennsylvania.
  - Based on the data in the graph, **describe** the relationship between the concentration of methane in well water and the distance to a fracking well.
  - Based on the data in the graph, **identify** the minimum safe distance that a new water well should be located from an existing fracking well.
  - Explain** how fracking fluid is used to access oil and natural gas in sedimentary rock, such as shale, during the fracking process.
  - Identify** one negative geologic effect in an area where hydraulic fracturing (fracking) occurs.
- (b) The volume of water used for oil and gas extraction is 28 times greater than it was fifteen years ago. Much of the water used for oil and gas extraction comes from groundwater sources in arid or semiarid regions. This increased use of water for fracking may mean that less water is available for local use.
- The use of groundwater for fracking is an example of individuals using a shared resource for their own self-interest. **Identify** the environmental concept illustrated by this example of overuse of a shared resource.
  - Describe** one environmental problem that may result from increased use of groundwater for fracking in arid or semiarid regions.
  - Describe** how overuse of coastal groundwater supplies can result in water that is unsuitable for human consumption.

- (c) In addition to water quality issues caused by fossil fuel extraction, air quality can also be negatively affected by combustion of oil and natural gas.
- (i) **Make a claim** for a realistic governmental action to improve air quality by reducing consumption of oil.
  - (ii) **Justify** the action proposed in part (c)(i) by stating a potential environmental advantage of that action, other than slowing global climate change.

---

**Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.**

3. Increasing global urbanization causes associated problems such as the formation of urban heat islands.
- (a) **Describe** how urbanization leads to the formation of urban heat islands.
- (b) Urban heat islands have been linked to a variety of environmental problems.
- (i) **Propose** a reasonable solution that could help lower the temperature increases caused by urban heat islands.
- (ii) **Justify** the solution proposed in part (b)(i) by providing one additional benefit other than reducing temperatures in urban heat islands.
- (c) Urban areas are increasingly using solar energy to generate electricity for residences and businesses.
- (i) As a result of improved technology, the efficiency of solar panels has changed over time. In 1992 a solar cell had a maximum efficiency of 15.9%. In 2017 a solar cell prototype capable of 44.5% efficiency was produced. **Calculate** the percent change in efficiency from the 1992 cell to the 2017 cell. **Show** your work.
- (ii) The average home in the United States uses 12,900 kWh of electricity per year. The local power company is raising the cost of purchasing electricity from \$0.11 per kWh to \$0.13 per kWh. Assuming a home uses the average kWh of electricity in one year, **calculate** the change in electricity cost for one year for the homeowner. **Show** your work.
- (iii) The roof of a typical house in the United States receives a total of four hours of sunlight per day that can be converted by solar panels into electricity. A house has 30 solar panels on its roof, and each panel generates a maximum output of 300 watts. **Calculate** how many kWh can be produced by the system at maximum output in one calendar year. **Show** your work.
- (d) **Explain** why the Northern Hemisphere receives more solar energy from the Sun between June and August than the Southern Hemisphere receives between June and August.

---

**Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.**

**STOP**

**END OF EXAM**