

ENVIRONMENTAL SCIENCE

SECTION II

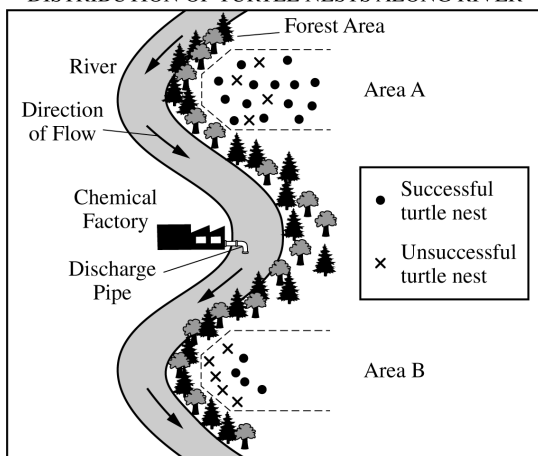
Time—1 hour and 10 minutes

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.**

1. 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.

DISTRIBUTION OF TURTLE NESTS ALONG RIVER



- (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. Pesticides have been utilized for many years to increase food production and control pest populations. Pesticide use can be both beneficial and harmful to humans and other organisms.

- (a) Pesticide use has advantages, disadvantages, and unintended consequences on human health. **Describe** one benefit to human health that can result from the use of pesticides.
- (b) **Identify** one way chemical pesticides can enter the human body.

Cotton farmers in the southern United States used a chemical pesticide to control an insect cotton-crop pest over a 40-year period. To study the effectiveness of the pesticide as an insect pest-control strategy, traps were placed in treated cotton fields and the number of pests captured were compared to application rates for the pesticide. The results of the study are shown in the table below.

Year	Grams of Pesticide Applied per Hectare	Number of Crop Insect Pests Captured
1960	0	700
1975	500	2
1980	500	3
1985	500	8
1990	550	14
1995	600	83
2000	700	150
2005	800	405
2010	900	727
2015	1,000	1,100

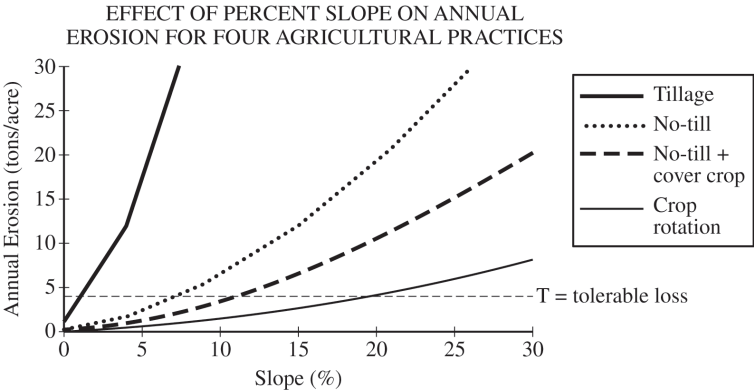
- (c) Use the data in the table to answer the following questions.
- (i) **Identify** the year when the pesticide was most effective at reducing the size of the pest population.
- (ii) **Describe** the change in the number of crop insect pests in the cotton fields over time.
- (iii) **Explain** how the change in the cotton-crop pesticide effectiveness between the initial application in 1975 and the latest application in 2015 illustrates genetic resistance in pests, based on the data in the table.
- (d) **Describe** TWO effects of pesticide use, other than death, on nontarget wildlife.

- (e) There are many problems associated with the repeated application of chemical pesticides to reduce pest populations.
- (i) Crop rotation is often used to reduce pesticide use. **Describe** the process of crop rotation.
- (ii) **Propose** one reasonable method, other than crop rotation, of reducing the use of pesticides in agricultural practices while still maintaining a high crop yield.
- (iii) **Justify** how the method proposed in (e)(ii) would provide a benefit to humans.

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1. Soil erosion is one of the most serious soil-degrading processes. Each year tons of soil erode from cropland, pastures, forests, and other places. The amount of erosion varies dramatically among various land-use types. The figure above shows the effects of different agricultural practices and slopes on annual erosion rates.

- (a) Refer to the graph above for the following.
- (i) **Identify** the scientific question that resulted in the data presented in the graph.
- (ii) **Identify** the agricultural practice that could be used on a 15% slope without leading to a higher than tolerable loss of soil.
- (iii) **Describe** the effect of adding a cover crop compared to using the no-till method.
- (iv) **Identify** one natural mechanism of soil erosion.

(b) Sediment from erosion can enter streams and affect water quality. One way sediment can enter a stream is from nearby road construction. Two methods to reduce sediment run-off in streams are to either put down straw bales or plant grass. The hypothesis to be tested is that straw bales reduce more sediment run-off than planted grass does. To test the hypothesis, two plots near a road under construction are measured. On one plot (A), straw bales are used to cover the soil, while a second plot (B) is planted with grass. The sediment discharge from each plot is measured after rainfall.

- (i) **Identify** the dependent variable stated in the hypothesis.
- (ii) **Describe** one way to add a control to improve the design of the study.
- (iii) **Identify** one variable that was not discussed that could affect the results of the study.

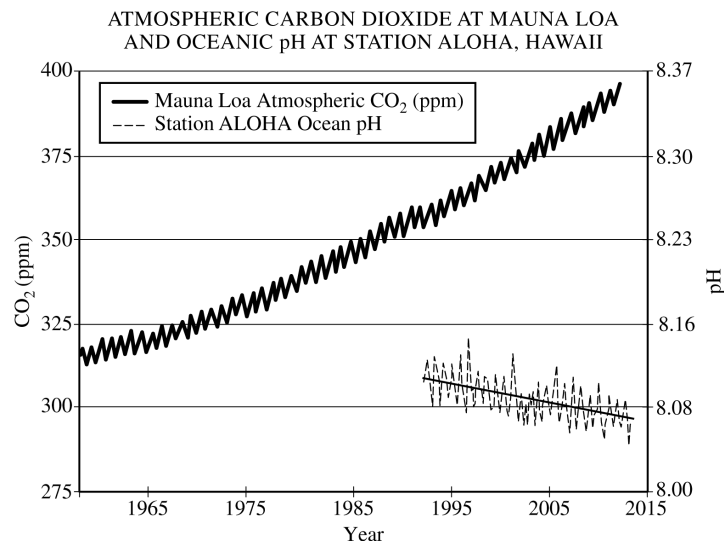
Sediments reaching streams affect water clarity, which is tested by determining turbidity. Turbidity can be determined by measuring the depth at which a submerged object can no longer be seen from the surface.

Sample Group	Turbidity
Straw bale plots (plot A)	12 cm
Planted grass plots (plot B)	28 cm

- (iv) Based on the data in the table above, **make a claim** about the stated hypothesis.
- (c) Several fish species lay their eggs in the gravel in the streams under investigation in the study.
- (i) **Describe** the type of survivorship curve expected for these fish species.
- (ii) **Explain** why the input of sediment to a stream can negatively affect reproduction of fish that lay their eggs in the gravel of the streambed.

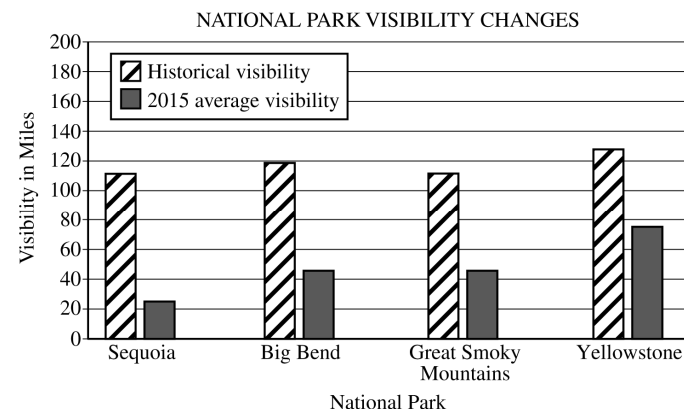
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3. The graph shows measurements of atmospheric levels of carbon dioxide (CO_2) at Mauna Loa Observatory, Hawaii, and the measurements of pH levels in the ocean nearby at Station ALOHA. Measurements of pH began in 1992.



- (a) Use the graph above to answer the following questions.
- Determine** the concentration of CO_2 (in ppm) recorded at Mauna Loa in 2005.
 - Determine** the pH recorded at Station ALOHA in 2005.
- (b) Changes in atmospheric carbon dioxide affect Earth's oceans.
- Predict** the effect of increased concentration of atmospheric CO_2 on the concentration of CO_2 in the ocean.
 - Based on the data, **identify** the relationship between the concentration of atmospheric CO_2 and the pH of ocean water.
 - Provide** the complete chemical equation that represents the reaction between oceanic carbon dioxide (CO_2) and water (H_2O).
 - Identify** the specific environmental problem that directly results from the decrease in pH of Earth's oceans.
- (c) Changes in pH in the world's oceans pose a risk to many marine organisms.
- Explain** why certain organisms, in particular those with calcium carbonate shells or exoskeletons, are threatened by the decreasing pH levels measured in seawater.
 - Other than threats posed by decreasing pH, **identify** an additional anthropogenic threat to the world's coral reef ecosystems and **describe** how the threat damages the coral reefs and coral reef ecosystems.

4. One reason that people visit national parks is to view the scenery. Visibility at the four parks in the graph has been reduced over time so that by 2015 the visibility was an average of 70 miles less than the historical visibility. Regional air pollutant sources are commonly located over 100 miles away from national parks.

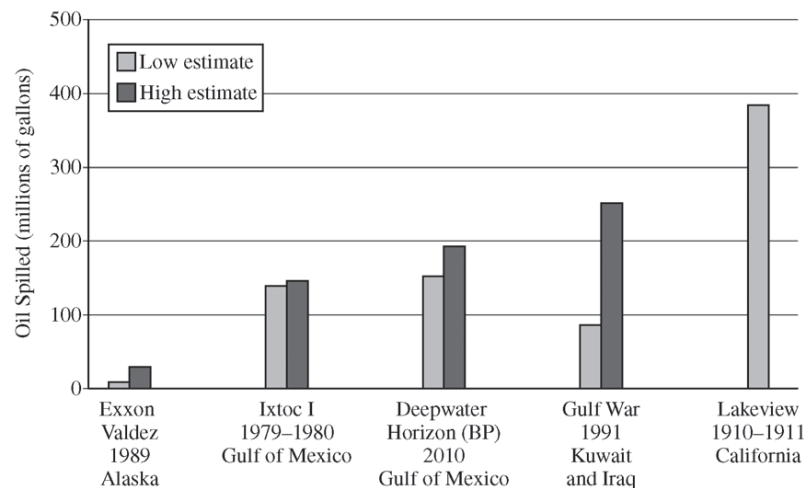


- (a) Based on the data provided in the graph, **identify** the national park that had the greatest loss of visibility as of 2015 when compared with the historical natural visibility.
- (b) Visibility in national parks can be affected by many different air pollutants.
- Identify** a primary air pollutant.
 - Describe** how a primary air pollutant becomes part of the atmosphere.
 - Identify** a secondary air pollutant.
 - Describe** how a secondary air pollutant is formed within the atmosphere.
- (c) In 1990 Great Smoky Mountains National Park had a visibility of 25 miles. Visibility data for 2015 can be determined from the graph above.
- Calculate** the percentage increase in visibility from 1990 to 2015.
 - Discuss** TWO specific actions that the state or federal government could take or encourage to further improve the visibility in Great Smoky Mountains National Park.
- (d) Excluding air pollution, **discuss** TWO additional ways national park ecosystems are being degraded by high levels of visitor use.

STOP

END OF EXAM

VOLUME OF OIL RELEASED IN SELECTED INCIDENTS



3. Oil spills can be devastating in scope and damage. Since 1900, there have been many oil spills around the world that have had significant ecological and economic impacts.
- Using the data in the graph above, **determine** the maximum volume of oil estimated to have been spilled during the Deepwater Horizon (BP) incident.
 - Describe** TWO environmental problems that can result from oil spills in coastal areas.
 - Identify** one economic impact that results from oil spills in coastal areas.
 - Chemical dispersants have been used in cleanup efforts following major oil spills.
 - Discuss** both one advantage and one disadvantage of the use of chemical dispersants for oil spill cleanup.
 - Identify** either one biological or one physical method (other than chemical dispersal) used for oil spill cleanup in coastal waters or on beaches and **describe** how the method is used.
 - Catastrophic spills make up less than 20 percent of the oil that pollutes marine waters. **Identify** one other source of oil contamination and **explain** how the oil from this source enters marine waters.
 - Petroleum has many uses as a raw material for consumer goods. **Identify** one substitute for petroleum in a specific consumer product (other than fuel).