

2021

AP[®] CollegeBoard

AP[®] Environmental Science

Free-Response Questions

Set 2

AP[®] Environmental Science 2021 Free-Response Questions

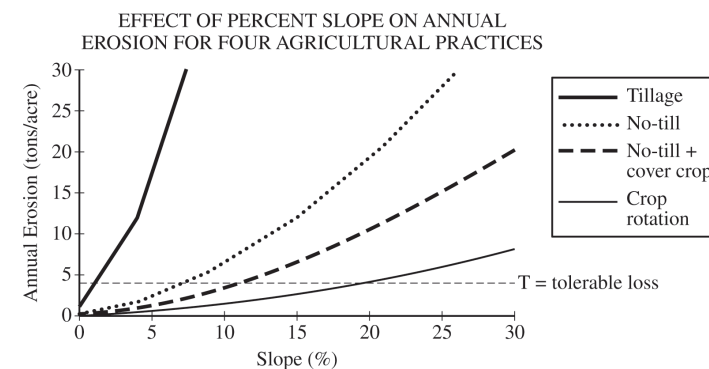
ENVIRONMENTAL SCIENCE

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. 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.

- Identify** the scientific question that resulted in the data presented in the graph.
- Identify** the agricultural practice that could be used on a 15% slope without leading to a higher than tolerable loss of soil.
- Describe** the effect of adding a cover crop compared to using the no-till method.
- 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

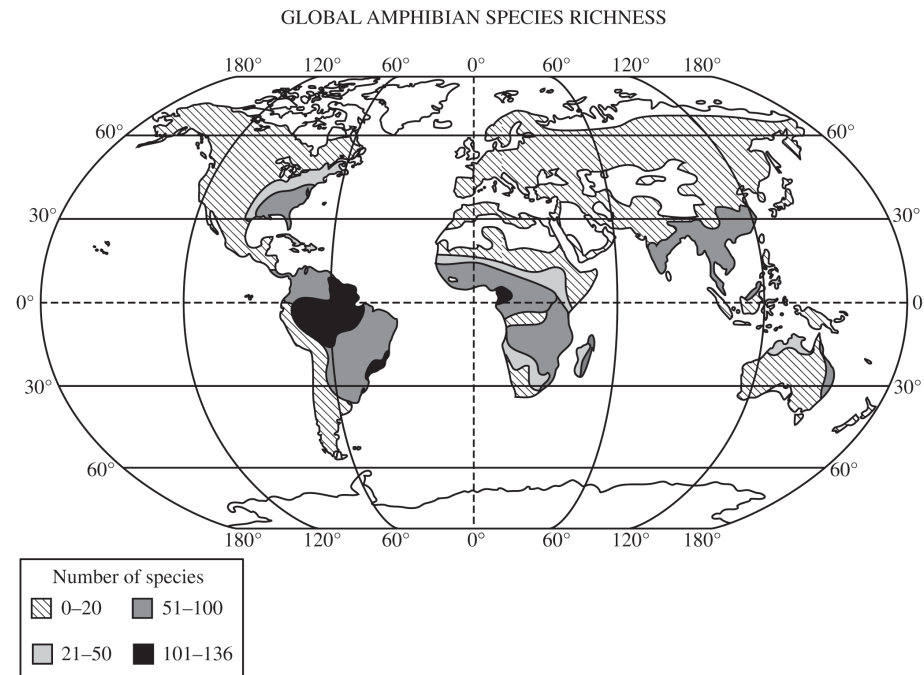
(iv) Based on the data in the table above, **make a claim** about the stated hypothesis.

(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.

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. Biodiversity around the world is changing as a result of anthropogenic influences.

(a) The map represents species richness of amphibians around the globe. Use the map to answer the following questions.

(i) **Identify** the latitudinal range with the greatest amphibian species richness.

(ii) **Identify** what biome this range most likely represents.

(iii) **Describe** one reason amphibian species richness would tend to be highest in this region.

(b) There are many environmental threats facing amphibians today, such as deforestation. **Describe** one possible anthropogenic reason for deforestation.

(c) Many factors influence biodiversity.

(i) **Explain** how the species richness of an ecosystem influences its response to environmental stressors.

(ii) **Explain** why amphibian biodiversity is declining globally, other than from deforestation.

(d) Currently, wildlife species are going extinct at an alarming rate. To combat this threat, governments around the world have enacted legislation and signed treaties to protect species threatened by extinction.

- (i) **Identify** one specific piece of legislation that has been designed to protect species threatened by extinction.
- (ii) **Explain** how the requirements of the legislation identified in part (d)(i) specifically protect species threatened by extinction.
- (e) A town is considering selling an undeveloped parcel of land along its border for residential developments. The square parcel of land consists of approximately 30% wetland and 70% pasture. The wetland runs through the middle of the property for its entire width and is home to three native frog species.
- (i) **Propose** a viable solution that will result in the protection of the native frog species while still allowing for maximum profit of the property development.
- (ii) **Justify** the solution proposed in (e)(i) by describing a potential advantage of the plan, other than frog protection.

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. Approximately 350 coal-fired power plants in the United States are older than the 30-year anticipated life-span for a coal generator. One problem with these aging power plants is that many lack the necessary modern air pollution controls. Additionally, there are concerns about rising fuel costs, so many utility companies are planning to retire coal-fired plants and build new natural-gas power plants.
- (a) **Describe** why coal is considered a nonrenewable energy source.
- (b) **Describe** one potential environmental advantage of replacing a coal-fired power plant with a natural-gas power plant.
- (c) **Describe** one economic advantage of using natural gas, rather than coal, in producing electricity.
- (d) When natural gas is used to heat homes, it can produce carbon monoxide gas, which can lead to carbon monoxide poisoning in humans. **Propose** a solution to reduce the incidence of carbon monoxide poisoning in humans.

Particulate matter is another common pollutant in emissions from vehicles, coal-fired power plants, and various other sources. One size of particulates, $\text{PM}_{2.5}$, presents a particular risk to human health.

ATMOSPHERIC CONCENTRATION OF PARTICULATE MATTER IN 1990 AND 2016

Year	Average Annual Atmospheric Concentration of $\text{PM}_{2.5}$ ($\mu\text{g}/\text{m}^3$)
1990	85
2016	188

- (e) **Calculate** the percent change in the average annual $\text{PM}_{2.5}$ concentration in the air from 1990 to 2016. **Show** your work.
- (f) Trees can remove $\text{PM}_{2.5}$ from the atmosphere when particulates settle on the leaves and are subsequently washed onto soil by rain. The average annual removal of $\text{PM}_{2.5}$ is 2.3 kilograms per hectare. **Calculate** the decrease in $\text{PM}_{2.5}$ removal in kilograms if logging reduced a forested area from 50,000 hectares to 43,000 hectares. **Show** your work.
- (g) Research has shown that hospital admissions for cardiovascular problems increase 1% with every 10% increase in $\text{PM}_{2.5}$ concentration. A city experienced a 23% increase in $\text{PM}_{2.5}$ concentration and had 7,390 hospital admissions for cardiovascular issues over a one-year period. **Calculate** the anticipated increase in the number of hospital admissions for cardiovascular issues during the next year if the $\text{PM}_{2.5}$ concentration continues to rise at an identical rate. **Show** your work.

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