

2024



AP[®] Environmental Science

Scoring Guidelines

Set 2

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Question 1: Design an Investigation

10 points

- | | | |
|-------|---|----------------|
| (a) | Identify the ecological change over time illustrated in the diagram. <ul style="list-style-type: none">• Primary Succession | 1 point |
| <hr/> | | |
| (b) | Identify the stage in which pioneer species first appear. <ul style="list-style-type: none">• II/2 | 1 point |
| <hr/> | | |
| (c) | Describe how soil forms from stage II to stage III. <p>Accept one of the following:</p> <ul style="list-style-type: none">• Wind/rain/weather can erode the rock/parent material.• Wind/rain can break down rocks.• Pioneer species (lichen/algae/fungi) die off adding small amounts of organic material.• Pioneer species (lichens/algae/fungi) help break down rocks. | 1 point |
| <hr/> | | |
| (d) | Identify a cultural ecosystem service that may be provided by a mature forest. <p>Accept one of the following:</p> <ul style="list-style-type: none">• Recreation• Aesthetic enjoyment• Spiritual use• Ecotourism• Education | 1 point |
| <hr/> | | |
| (e) | Identify a testable hypothesis being investigated by the researchers. <p>Accept one of the following:</p> <ul style="list-style-type: none">• The removal of trees/clear-cutting will lead to an increase/decrease in water quality (temperature/turbidity/dissolved oxygen).• The removal of trees/clear-cutting will have no effect on water quality (temperature/turbidity/dissolved oxygen).• Water quality (temperature/turbidity/dissolved oxygen) will increase/decrease between stations.• Water quality (temperature/turbidity/dissolved oxygen) will not change between stations. | 1 point |
| <hr/> | | |
| (f) | Identify the independent variable in the experiment. <p>Accept one of the following:</p> <ul style="list-style-type: none">• Presence or absence of clear-cutting• Intact or clearcut forest• Location of stream monitoring stations | 1 point |

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(g)	Describe the purpose of forest A in the experiment.	1 point
	Accept one of the following:	
	- Forest A/A/It is included so the researchers can compare the temperature/turbidity/water quality in clear-cut areas (forest B) to intact areas. - Forest A/A/It acts as a control so researchers can compare intact areas/Forest A to clear-cut areas/Forest B.	
(h)	Explain why the water temperature might change because of clear-cutting trees in forest B.	1 point
	Accept one of the following:	
	- Water temperature will increase because there will be no/fewer trees to block the sunlight. - Water temperature will increase because there will be additional sediment from erosion. - Water temperature will increase because more sunlight will reach the water surface.	
(i)	Explain why an indicator of water quality other than temperature could be altered by the golf course in forest B.	1 point
	Accept one of the following:	
	- There could be a decrease in dissolved oxygen because fertilizer runoff leads to algal blooms/eutrophication. - There could be a decrease in sedimentation/turbidity because the grass will decrease erosion compared to the clear-cut land. - There could be an increase in nitrates/phosphates due to fertilizer runoff resulting in algal growth/bloom.	
(j)	Explain how the aquatic organisms living in the lake illustrated in the diagram of forest B are likely to be affected by the new golf course.	1 point
	Accept one of the following:	
	- Aquatic organisms would die off from a lack of oxygen created by the decomposition of algae/eutrophication. - Aquatic organisms would survive at a higher rate because there is less sediment to suffocate them/clog their gills. - Aquatic organisms would die off due to increased toxicity from pesticide runoff.	
Total for question 1		10 points

Question 2: Analyze an Environmental Problem and Propose a Solution 10 points

(a)	Based on the data in the graph, identify the year with the highest percentage of forest.	1 point
	1700	
(b)	Based on the data in the graph, describe the relationship between the land use changes in the wild grasslands and grazing from 1700 to 1950.	1 point
	Accept one of the following:	
	- The percentage/amount of wild grasslands has decreased, and the percentage/amount of grazing (land) has increased. - The two variables have an inverse relationship.	
(c)	Identify an environmental problem associated with overgrazing by livestock.	1 point
	Accept one of the following:	
	- Loss of vegetation - Soil erosion - Desertification - Sedimentation/turbidity in waterways - Soil compaction	
(d)	A student hypothesized that the change in the percentage of forest from 1700 to 2018 has decreased atmospheric carbon dioxide concentrations. Explain whether the hypothesis is supported or refuted based on the data in the graph.	1 point
	The hypothesis is refuted/disproved/not supported. The percentage of forest has decreased, so the amount of photosynthesis/carbon sequestration has decreased.	
(e)	Describe a water-related environmental problem associated with urbanization.	1 point
	Accept one of the following:	
	- Increased runoff/flooding because urban areas have more impermeable surfaces. - Decreased groundwater/saltwater intrusion because urban areas have many people/groundwater is overused. - Increased water pollution because precipitation/runoff can carry contaminants/pollutants/waste. - Destruction of aquatic habitats from increased development/land use changes.	

- (f) **Describe** a potential response to mitigate the environmental problem identified in part (e). **1 point**

Accept one of the following:

Environmental problem identified in part (e)	Potential response to mitigate environmental problem
Increased runoff/flooding	- Use permeable road/parking lot materials. - Set aside green spaces/parks/conservation areas. - Construct green roofs/rain gardens/storm water retention ponds/basins.
Decreased groundwater/saltwater intrusion	- Use permeable road/parking lot materials. - Establish groundwater conservation/management plans. - Set aside green spaces/parks/conservation areas in recharge zones. - Construct green roofs/rain gardens/storm water retention ponds/basins.
Increased water pollution	- Encourage walking/biking or other methods of transportation. - Reduce use of home pesticides/fertilizers. - Reduce use of road salts/de-icing chemicals - Pick up trash and litter along waterways. - Dispose of toxic chemicals (for example, used oil and household cleaners).
Destruction of aquatic habitats from increased development/land use changes	- Create conservation areas/preserves/wetlands to protect aquatic habitats. - Restore degraded aquatic habitats.

- (g) **Explain** why there are fewer bobcats present on the farmland now compared to several decades ago. **1 point**

Accept one of the following:

- Loss of forest habitat has led to a decrease in resources/food/shelter/ mates/migration.
- Trapping/hunting has reduced the bobcat population.

- (h) **Describe** a disadvantage of introducing only a small population of bobcats. **1 point**

Accept one of the following:

- Small populations have lower genetic diversity.
- Genetic bottlenecks can lead to inbreeding/passing on negative traits.
- Small populations are more vulnerable to diseases/disturbances like wildfire.
- Small populations do not control small mammals/pests as well as large populations.
- Small populations are less likely to survive.

- (i) **Propose** a solution to improve the chances that the bobcat reintroductions will be successful in reestablishing wild populations. **1 point**

Accept one of the following:

- Increase connectivity/build habitat corridors (so bobcats can safely mate/find food/build dens).
- Restore/reforest/preserve areas of bobcat habitat.

- (j) **Justify** the solution proposed in part (i) by describing an additional advantage, other than reestablishing the bobcat population near the farms. **1 point**

Accept one of the following:

Solution proposed in part (i)	Justification of the proposed solution by stating an advantage
Increase connectivity/build habitat corridors (so that bobcats can safely mate/find food/build dens)	- Habitat corridors can be used by other species. - Habitat corridors would increase biodiversity/population of other species. - Habitat corridors can attract other species that might be beneficial for farmers (such as predators of pests and/or pollinator species). - Habitat corridors could help decrease road kills/the frequency of car accidents with wildlife.
Restore/reforest/preserve areas of bobcat habitat	- Restored habitat can be used by other species. - Restoration/reforestation/preservation could increase diversity/improve air quality/improve water quality. - An increase in the number of trees will improve aesthetic value/enhance tourism/reduce erosion/serve as a carbon sink.

Total for question 2 10 points

**Question 3: Analyze an Environmental Problem
and Propose a Solution Doing Calculations**
10 points

(a) **Identify** a typical type of plant that would be used in a desert-tolerant landscaping. **1 point**

Accept one of the following:

- Cactus/cacti
- Succulent plants
- Drought-tolerant plants

(b) **Justify** the removal of landscaping and lawns that use grasses not native to the local area by describing an additional advantage, other than reducing the amount of water needed for irrigation. **1 point**

Accept one of the following:

- Native desert plants support habitat/provide food for local/native wildlife.
- Less mowing leads to decreased yard maintenance time/costs.
- Desert tolerant plants need less fertilizer/pesticide.
- Creates jobs for landscapers to remove/replace turf.
- Decreased use of gas-powered yard tools reduces air pollution/noise pollution/gasoline consumption.

(c) **Describe** how a prescribed burn would reduce the severity and spread of forest fires. **1 point**

Accept one of the following:

- Prescribed burns/they remove undergrowth, decreasing fuel/flammable material.
- Prescribed burns/they thin forests/create a fire break, reducing the spread of fires.

(d) **Describe** a disadvantage of a prescribed burn in a forested ecosystem. **1 point**

Accept one of the following:

- Reduces habitat for wildlife/can harm or displace animals.
- Releases carbon dioxide, which contributes to climate change.
- Releases particulates/air pollutants, which worsens air quality.
- Runoff following a prescribed burn can degrade water quality.
- Reduces competition, which helps invasive species spread/expand.

(e) **Calculate** the number of million acre-feet (maf) of water currently in Lake Powell. **Show** your work. **1 point**

One point for the correct setup to calculate number of million acre-feet (maf) of water currently in the lake:

Accept one of the following:

- $25.16 \text{ maf} \times 36\%$
- 25.16×0.36

One point for the correct calculation of the number of million acre-feet (maf) of water currently in the lake: **1 point**

Accept one of the following:

- 9.0576
- 9.058
- 9.06
- 9.1

Total for part (e) 2 points

(f) The watershed of the Upper Colorado River contributes an average of 9.60 maf of water to Lake Powell annually. The melted mountain snow found in the watershed contributes 50% of the average river flow into Lake Powell. In 2021, the river flow was 36% of the annual average. Assuming that all resources to that flow contributed with the same proportions as in prior years, **calculate** the amount of water (in million acre-feet) that was contributed by the melted mountain snow in 2021. **Show** your work. **1 point**

One point for the correct setup to calculate amount of water in million acre-feet that was contributed by the melted mountain snow:

Accept one of the following:

- $9.60 \text{ maf} \times 36\% \times 50\%$
- $9.60 \text{ maf} \times 0.36 \times 0.5$
- $9.60 \times 0.36 \times 0.5$

One point for the correct calculation of the amount of water in million acre-feet: **1 point**

Accept one of the following:

- 1.728
- 1.73
- 1.7

Total for part (f) 2 points

- (g) The average household in the United States consumes 5.0×10^4 gallons of water in a year. **Calculate** the number of households that could be supported for one year by the average flow of 9.60 maf of water into Lake Powell. **Show** your work. **1 point**

One point for the correct setup to calculate the number of households that could be supported for one year by the average watershed flow:

Accept one of the following:

- $9.60 \text{ maf} \times \frac{3.26 \times 10^{11} \text{ gallons}}{1 \text{ maf}} \times \frac{1 \text{ household}}{5.0 \times 10^4 \text{ gallons}}$
- $9.60 \text{ maf} \times \frac{3.26 \times 10^{11} \text{ gallons}}{5.0 \times 10^4 \text{ gallons}}$
- $9.60 \times \frac{3.26 \times 10^{11}}{5.0 \times 10^4}$

One point for the correct calculation of the number of households: **1 point**

Accept one of the following:

- 62,592,000
- 6.2592×10^7

Total for part (g) 2 points

Total for question 3 10 points