2021

AP® Environmental Science

Scoring Guidelines
Set 2

Question 1: Design an Investigation — 10 points

(a) (i) **Identify** the scientific question that resulted in the data presented in the graph. **1 point**

Accept one of the following:

- What is the relationship between slope and annual erosion rate for four different land use types?
- Does crop rotation/tilling/not tilling/using cover crops on various slopes increase/decrease/change erosion rates?

(ii) **Identify** the agricultural practice that could be used on a 15% slope without leading to a higher than tolerable loss of soil. **1 point**

- Crop rotation

(iii) **Describe** the effect of adding a cover crop compared to using the no-till method. **1 point**

Accept one of the following:

- Adding a cover crop reduces the annual rate of soil erosion compared to using the no-till method.
- Adding a cover crop allows planting on greater sloped land before reaching tolerable loss as compared for the no-till method.

(iv) **Identify** one natural mechanism of soil erosion. **1 point**

Accept one of the following:

- Moving/flowing water
- Rainfall
- Wind

Total for part (a) **4 points**

(b) (i) **Identify** the dependent variable stated in the hypothesis. **1 point**

Accept one of the following:

- The amount of sediment discharge
- The amount of sediment run-off

(ii) **Describe** one way to add a control to improve the design of the study. **1 point**

Accept one of the following:

- Add a plot that is bare/does not have straw bales or grass (no ground cover).
- Measure sediment discharge/runoff prior to placing straw bales or planting grass compared to discharge after the bales/grass are in place (pre-/post-tests).

(iii) **Identify** one variable that was not discussed that could affect the results of the study. **1 point**

Accept one of the following:

- Slope of the plots
- Amount of rainfall
- Composition of the roads
- Distance of the plots from road/stream
- Size of the plots
- Type of soil at the plots
- When the data are collected at the plots (how quickly after rainfall)

(iv) Based on the data in the table above, **make a claim** about the stated hypothesis. **1 point**

Accept one of the following:

- The stated hypothesis is rejected as more sediment resulted from straw bale plots (plot A) than grass planted plots (plot B).
- The data in the table shows that the grass is more effective at reducing sediment runoff. The hypothesis should be rejected.

Total for part (b) 4 points

(c) (i) **Describe** the type of survivorship curve expected for these fish species. **1 point**

Accept one of the following:

- Low survival rate in early life, followed by increased chances of survival as the organism matures.
- Most offspring die at a very young age and few reach maturity.

(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. **1 point**

Accept one of the following:

- Sediment can cover/bury eggs, which reduces the amount of oxygen, causing them to die.
- Sediment takes away usable habitat/space resulting in fewer areas for them to lay eggs causing fewer eggs to survive.
- Sediments can carry toxic/poisonous chemicals, which can negatively impact the eggs and decrease egg survival.
- An increase in sediment can increase the water temperature and result in less dissolved oxygen/too warm water, which can decrease the viability of the eggs that have already been laid.
- Sediment can increase water turbidity, which decreases fish navigation/ability to forage/efficiency of oxygen use which decreases the amount of eggs laid.

Total for part (c) 2 points

Total for question 1 10 points

Question 2: Analyze an Environmental Problem and Propose a Solution

10 points

(a) (i)	**Identify** the latitudinal range with the greatest amphibian species richness. Accept one of the following: • Between the Tropic of Cancer and the Tropic of Capricorn • The range between 30 degrees N and 30 degrees S latitude • The range between 10 degrees N and 15 degrees S latitude	**1 point**
(ii)	**Identify** what biome this range most likely represents. • Tropical Rainforest	**1 point**
(iii)	**Describe** one reason amphibian species richness would tend to be highest in this region. Accept one of the following: • More rainfall/warm temperatures year-round are the preferred conditions for amphibians. • Greater biodiversity/higher NPP provides more habitat/food sources/niches.	**1 point**
	Total for part (a)	**3 points**
(b)	There are many environmental threats facing amphibians today, such as deforestation. **Describe** one possible anthropogenic reason for deforestation. • Human demand for agriculture/housing/firewood/forest products (medicine/food/lumber).	**1 point**
(c) (i)	**Explain** how the species richness of an ecosystem influences its response to environmental stressors. • An ecosystem with greater species richness/diversity is more resilient/resistant to environment stressors because some species will survive helping to restore/stabilize the ecosystem.	**1 point**

(ii) **Explain** why amphibian biodiversity is declining globally, other than from deforestation. **1 point**

Accept one of the following:

- Increasing water pollution including:
    - Pollution from pharmaceuticals that cause reproductive harm/decrease reproductive success.
    - Pesticide pollution that is absorbed via the skin and is toxic to amphibians leading to death.
    - Endocrine disruptors (such as atrazine) can alter reproductive development leading to decreased number of successful offspring.
- Pesticide use reduces food sources for amphibians (insects), leading to decreasing population size.
- Microclimatic changes from overall global climate change (e.g., warmer, drier conditions in previously cool, moist areas, loss of wetlands) decreases available habitat leading to a decline in population size.
- Illegal amphibian trafficking removes species from an area leading to a decline in population sizes.
- Introduction of invasive species that compete for niche space leading to a decline in population sizes.
- Habitat fragmentation from human activity would limit range/reduce the ability to access resources, decreasing survival.
- Fungal infections (such as Chytrid) cause their skin to dry out, and they cannot breathe.

Total for part (c) **2 points**

(d) (i) **Identify** one specific piece of legislation that has been designed to protect species threatened by extinction. **1 point**

Accept one of the following:

- Endangered Species Act (ESA)
- Convention on the International Trade of Endangered Species (CITES)
- Lacey Act

(ii) **Explain** how the requirements of the legislation identified in part (d)(i) specifically protect species threatened by extinction. **1 point**

Accept one of the following**:**

Legislation identified in (d)(i)	Explanation of requirements that specifically protect species threatened by extinction
• Endangered Species Act (ESA)	• Lists endangered/threatened plant and animal species and prevents them from being killed or harmed. • Designates/protects critical habitat to promote survival and recovery of listed species. • Creates plans to restore populations to healthy sizes. • Identifies species that are threatened before they become endangered to provide protections.
• Convention on the International Trade of Endangered Species (CITES)	• A global agreement that protects endangered/threatened plants and animals (including goods such as ivory, shark fins, or rhinoceros' horns) by banning/regulating the trade of these species.
• Lacey Act	• Prohibits the trade of wildlife, fish, and plants that have been illegally taken, possessed, transported, or sold.

Total for part (d) **2 points**

(e) (i) **Propose** a viable solution that will result in the protection of the endemic frog species while still allowing for maximum profit of the property development. **1 point**

Accept one of the following:

- Move/transplant the frog populations to an adjacent undeveloped area prior to development.
- A portion of the wetland can be designated as a park/preserve.
- Wildlife corridors (land/bridges) can be built/created on a portion of the wetlands.
- Restrict development within a minimum setback away from the wetland.
- Project developers can group buildings together/can build up, not out.

(ii) **Justify** the solution proposed in (e)(i) by describing a potential advantage of the plan, other than frog protection. **1 point**

Accept one of the following:

Solution proposed in (e)(i)	Justification of how solutions offer potential advantages, other than frog protection
• Move/transplant frogs	• Developers will only have a one-time disruption during the removal but will not have to deal with continued disruptions (such as increasing human population, increasing use of fertilizer/pesticides). • Developer will have the maximum amount of land available.
• Designate as a park/preserve	• By protecting areas, animal species will have more food and space availability increasing survival rates. • Potential educational/environmental draw of living near a park/preserve may allow the developer to charge higher rents for the apartments. • There is aesthetic value of the wetland and its species for the people that live there. • The preserved wetland area will help prevent flooding.
• Use of wildlife corridors	• By establishing corridors, the other species will also not be as greatly affected by multiple habitat fragments. • The animal species can continue to move back and forth for food, shelter, and reproduction by way of the habitat corridors.
• Setback	• By establishing setbacks, a buffer zone will be created between the development and the wetland area, filtering runoff into the wetland. • A buffer zone will add privacy for residents between the two developments.
• Project development	• By developing the apartments in groups/clusters and leaving preserved wetlands, the species will not be as affected by multiple habitat fragments.

Total for part (e) 2 points

Total for question 2 10 points

Question 3: Analyze an Environmental Problem and Propose a Solution

Doing Calculations — 10 points

(a) **Describe** why coal is considered a nonrenewable energy source. **1 point**

Accept one of the following:

- Nonrenewable energy sources like coal exist in a fixed/finite/limited amount.
- The formation rate of coal is less than the consumption/combustion rate of coal.

(b) **Describe** one potential environmental advantage of replacing a coal-fired power plant with a natural-gas power plant. **1 point**

Accept one of the following:

- Natural gas combustion emits fewer greenhouse gases/less CO_2.
- Natural gas combustion does not emit mercury/lead/cadmium/uranium.
- Natural gas combustion emits less NO_x/SO_x/reduces acid precipitation.
- Natural gas combustion produces less/no particulate matter/soot/smog.
- Transport of natural gas destroys/fragments less habitat or requires less fossil fuel use than transport of coal.
- Habitat destruction due to the impoundment of coal ash or coal slurry is negated.
- Coal extraction destroys habitat by strip mining or mountaintop removal.

(c) **Describe** one economic advantage of using natural gas, rather than coal, in producing electricity. **1 point**

Accept one of the following:

- Transport of natural gas (in pipelines) costs less than transport of coal (by rail).
- Natural gas (methane) harvested from a decomposition reaction (landfills, wastewater treatment plants, biodigesters) costs less than coal.
- There are fewer health-related issues linked to the burning of natural gas than are linked to burning coal, leading to lower health care costs for individuals or society as a whole.
- There are fewer pollution controls needed for a natural gas powerplant, decreasing the cost of operation/construction/permitting.
- There are lower combustion-residue disposal costs from the operation of natural gas burning powerplants than from coal-burning power plants.
- Natural-gas-burning power plants are much more efficient (more electricity output from the same energy input) than coal-burning power plants leading to lower fuel costs.

(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. **1 point**

Accept one of the following:

- Install/use/replace/update carbon monoxide detectors/alarms/sensors or replace the batteries within these devices.
- Perform regular maintenance on natural gas furnaces to ensure that minimal carbon monoxide is created or that the combustion products are properly vented/exhausted to the building exterior.
- Create laws or regulations that mandate that carbon monoxide detectors must be installed in all homes of any type.
- Use PSA's, billboards, or other methods to inform/educate the public about carbon monoxide poisoning.
- Change the home heating system to a method that does not include the combustion of a fuel that may produce carbon monoxide.

(e) **Calculate** the percent change in the average annual $PM_{2.5}$ concentration in the air from 1990 to 2016. **Show** your work. **1 point**

One point for the correct setup (must include units and multiplication by 100 to yield a true percentage) to calculate the percent change:

- $\frac{\left(188\,\mu g/m^3 - 85\,\mu g/m^3\right)}{85\,\mu g/m^3} \times 100$

One point for the correct calculation of the percent change: **1 point**

- 121%
- 120%
- 121.2%

Total for part (e) **2 points**

(f) Trees can remove $PM_{2.5}$ from the atmosphere when particulates settle on the leaves and are subsequently washed onto soil by rain. The average annual removal of $PM_{2.5}$ is 2.3 kilograms per hectare. **Calculate** the decrease in $PM_{2.5}$ removal in kilograms if logging reduced a forested area from 50,000 hectares to 43,000 hectares. **Show** your work. **1 point**

One point for the correct setup (must include units) to calculate the number of kilograms of $PM_{2.5}$:

- $(50{,}000\,\text{ha} - 43{,}000\,\text{ha}) \times \frac{2.3\,\text{kg}}{\text{hectare}}$
- $50{,}000\,\text{ha} \times 2.3\ \text{kg/ha} = 115{,}000\,\text{kg}$; $43{,}000\,\text{ha} \times 2.3\ \text{kg/ha} = 98{,}900\,\text{kg}$
  $115{,}000\,\text{kg} - 98{,}900\,\text{kg}$

	One point for the correct calculation of the number of kilograms of $PM_{2.5}$: • 16,100 kilograms of $PM_{2.5}$ • 16,000 kilograms of $PM_{2.5}$	**1 point**
		Total for part (f) 2 points
(g)	Research has shown that hospital admissions for cardiovascular problems increase 1% with every 10% increase in $PM_{2.5}$ concentration. A city experienced a 23% increase in $PM_{2.5}$ 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 $PM_{2.5}$ concentration continues to rise at an identical rate. **Show** your work.	**1 point**
	One point for the correct setup to calculate the increase in hospital admissions: • $\frac{0.23}{0.10} \times 0.01 \times 7,390 \text{ admissions}$ • $\frac{0.23}{0.10} \times \frac{1}{100} \times 7,390 \text{ admissions}$ • $\frac{23\%}{10\%} \times 1\% \times 7,390 \text{ admissions}$	
	One point for the correct calculation of the increase in hospital admissions. Accept one of the following: • 169 more admissions • 170 more admissions	**1 point**
		Total for part (g) 2 points
		Total for question 3 10 points