

2022

AP[®]

 CollegeBoard

AP[®] Environmental Science

Scoring Guidelines Set 2

Question 1: Design an Investigation**10 points**

(a) (i) **Identify** the land use that covers the least amount of area in the Mississippi River watershed, based on the diagram. **1 point**

- Urban

(ii) **Describe** one way that land use practice at location X in the diagram could contribute to the dead zone in the Gulf of Mexico. **1 point**

Accept one of the following:

- Fertilizer used on croplands is washed into the streams and rivers in the watershed and feeds the growth of algae once it reaches the Gulf.
- Concentrated animal feeding operations generate large amounts of organic wastes that can move into streams and rivers, feeding the growth of algae once it reaches the Gulf.
- Treated or untreated (overflows) sewage released from wastewater treatment plants feeds the growth of algae once it reaches the Gulf.

(iii) **Describe** one way that urban areas in the Mississippi River watershed could contribute to the dead zone in the Gulf of Mexico. **1 point**

Accept one of the following:

- Wastewater treatment facilities in urban areas may release nutrients in treated wastewater and/or overflows, with this effluent flowing into the Gulf.
- Impervious surfaces in urban areas can increase the movement/runoff of lawn fertilizers or high-phosphate detergents that move onto pavement areas and flow into the Gulf.

Total for part (a) 3 points

(b) (i) **Describe** how a dead zone affects marine organisms living in the Gulf of Mexico. **1 point**

Accept one of the following:

- Many organisms are forced to migrate or will die as a result of low dissolved oxygen levels in the water.
- Many organisms are forced to migrate or will die as a result of algal blooms that block sunlight from reaching underwater plants (submerged aquatic vegetation).

(ii) **Describe** one economic effect on communities along the Gulf of Mexico that can result from the presence of the dead zone. **1 point**

Accept one of the following:

- Decreased fish catch/decreased income for fishing industry
- Decreased tourism/lower tourism revenues
- Increased fuel costs for fishing vessels that need to travel farther to locate fish, therefore there will be a decrease in income/profits for fishing industry
- Increased costs for consumers as a result of a limited supply of fish

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- (iii) Describe** one factor that causes the area of the dead zone in the Gulf of Mexico to increase during the summer months. **1 point**

Accept one of the following:

- Increased runoff of nitrates/phosphates/potassium from fertilizer used during the growing season leads to increased algal growth in the summer months.
- Increased precipitation/snowmelt/water volume carries more fertilizer runoff from urban or agricultural areas leading to increased algal growth.
- Higher water temperatures in the summer decrease the concentration of dissolved oxygen as warm water does not hold as much dissolved oxygen as cold water.
- Increased runoff of fertilizer or high-phosphate detergents used in urban areas leads to increased algal growth in the summer months.

Total for part (b) 3 points

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- (c) (i) Identify** a testable hypothesis for the study. **1 point**

Accept one of the following:

- If riparian buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will be lower than areas without riparian buffers.
- If riparian buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will be higher than areas without riparian buffers.
- If riparian buffers are present in agricultural areas, then the level of nitrates/phosphates/nutrients downstream will remain the same in areas with and without riparian buffers.

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- (ii) Describe** a control that the researchers could use in the study. **1 point**

- Stream sites that are 100 meters downstream from areas without riparian buffer zones

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- (iii) Identify** one water quality test, other than measuring nitrates or phosphates, that the researchers could use to evaluate how riparian vegetation buffers affect water quality. **1 point**

Accept one of the following:

- Turbidity
 - Total suspended solids (TSS)
 - Dissolved oxygen
 - Water temperature
 - Fecal coliform
 - Conductivity
 - pH
 - Biological oxygen demand (BOD)
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- (iv)** During the investigation, researchers discovered that some of the land next to one of the streams with a riparian vegetation buffer is going to be converted from cornfields into a large-scale concentrated animal feeding operation. **Explain** one way that this change in land use could alter the results of the study. **1 point**

Accept one of the following:

- There would be a decline in water quality from increased nutrients/increased coliform bacteria in the runoff because there is animal waste in the areas near concentrated animal feeding operations that are high in nutrients/coliform bacteria.
- There would be a decline in water quality from increased turbidity/increased total suspended solids in the streams near the concentrated animal feeding operations because particles from animal wastes enter the stream/there is increased disruption of the stream bed from animals in the water.
- There would be a decline in water quality from increased water temperature because the increased turbidity/suspended solids in streams near the concentrated animal feeding operations absorb sunlight/heat.
- There would be a decline in water quality from increased conductivity because there is increased water temperature/increase dissolved salts in streams near concentrated animal feeding operations.
- There would be a decline in water quality from antibiotics/veterinary drugs in runoff near the concentrated animal feeding operations because antibiotics/drugs are used in livestock operations but not to grow crops.

Total for part (c) 4 points

Total for question 1 10 points

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

(a) (i) Based on the data in the graph, **identify** the habitat type with the greatest number of lizards. **1 point**

- Clearings, Gardens

(ii) Based on the data in the graph, **describe** the relationship between the lizard numbers observed on islands with and without mongoose populations. **1 point**

Accept one of the following:

- Lizard populations are smaller on islands where mongooses are present than on mongoose-free islands.
- Lizard populations are larger on mongoose-free islands than on islands where mongooses are present.
- The relationship between lizard number counted and mongoose population is an inverse relationship.

Total for part (a) 2 points

(b) Based on the theory of island biogeography, **describe** the characteristics of an island with the greatest species diversity. **1 point**

- A large island that is located near the mainland will contain the greatest species diversity.

Total for part (b) 1 point

(c) (i) **Describe** one environmental problem caused by invasive animal species. **1 point**

Accept one of the following:

- Invasive species outcompete native species for resources, causing food web disruptions/trophic cascades/habitat loss.
- Invasive species outcompete/prey on native organisms, decreasing biodiversity/reducing population size of native species.

(ii) Invasive species are often pests. **Make a claim** that proposes one way to control pest species. **1 point**

Accept one of the following:

- Introduce biological controls, like natural predators of the species, to reduce the number of pests.
- Use chemical controls, such as pesticides, to kill off pests.
- Use manual/mechanical methods to remove plant species.
- Trap/hunt animal species and kill/remove them from the area.

(iii) Justify the solution proposed in (c)(ii) by providing an additional benefit of the solution. **1 point**

Accept one of the following:

Solution proposed in (c)(ii)	Justification of solution with additional benefit
Introduce biological controls like natural predators of the species to reduce the number of pests	<ul style="list-style-type: none"> Method least likely to harm other species because the pest species can be specifically targeted Harmful synthetic chemicals are not introduced into the environment
Use chemical controls, such as pesticides, to kill off pests	<ul style="list-style-type: none"> Quick/efficient method to reduce/eliminate pest species
Use manual/mechanical methods to remove plant species	<ul style="list-style-type: none"> Method least likely to harm other species because the pest species can be specifically targeted Harmful synthetic chemicals are not introduced into the environment Financial gain from selling killed pest organisms
Trap/hunt animal species and kill/remove them from the area	<ul style="list-style-type: none"> Method least likely to harm other species because the pest species can be specifically targeted Harmful synthetic chemicals are not introduced into the environment Financial gain from selling killed pest organisms

Total for part (c) 3 points

(d) (i) Identify a provisioning ecosystem service provided by primary forests. **1 point**

Accept one of the following:

- Timber/lumber/wood
- Medicine
- Food

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- (ii) Based on the data in the graph, **explain** how replacing primary forests with sugarcane fields may have affected the number of lizards counted on the mongoose-free Pacific islands. **1 point**

Accept one of the following:

- The cleared land is preferred habitat for the lizards, which led to increased numbers of lizards in the sugar cane fields compared to the forests.
- The cleared land has fewer predators, which led to increased numbers of lizards counted in the sugar cane fields compared to the forests.
- The cleared land has more food for the lizards, which led to increased numbers of lizards in the sugar cane fields compared to the forests.

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- (iii) The long-term use of monocultures in commercial sugarcane farming is one cause of the ecological damage. **Describe** one problem associated with monocultures. **1 point**

Accept one of the following:

- Decreased genetic diversity of monoculture species
- Decreased species diversity
- Increased susceptibility of monoculture to disease/pests
- Depletion of nutrients from soil
- Increased use of irrigation water/fertilizer/pesticide

Total for part (d) 3 points

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- (e) **Describe** an advantage of crop rotation using legumes on soil fertility. **1 point**

Accept one of the following:

- Improved nitrogen fixation in the soil
- Less nitrogen-based fertilizers required

Total for part (e) 1 point

Total for question 2 10 points

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

10 points

- (a) **Identify** one negative human health effect linked to the exposure to pollutants resulting from the combustion of coal. **1 point**

Accept one of the following:

- Lung disease/respiratory diseases (asthma, COPD, bronchitis, lung cancer)
- Neurological damage
- Birth defects
- Heart disease
- Eye irritation/respiratory irritation/headaches

Total for part (a) 1 point

- (b) (i) **Describe** an environmental problem associated with coal ash waste disposal. **1 point**

Accept one of the following:

- Leaching from landfills/clay-lined pits
- Overflowing of coal ash into bodies of water
- Leaking and contamination of groundwater, soil, or nearby bodies of water
- Coal ash washing into bodies of water as a result of severe weather events
- Dry ash carrying into nearby bodies of water, increasing turbidity/decreasing photosynthesis

- (ii) A proposed solution is to dispose North Carolina's coal ash in clay-lined pits. **Justify** this solution by providing one advantage of using clay soil. **1 point**

- Clay is less permeable than unlined pits and can prevent the leaching of coal ash into soil/groundwater.

Total for part (b) 2 points

- (c) (i) **Calculate** the percent change in Charlotte's population from 2013 to 2019. **Show** your work. **1 point**

One point for the correct setup to calculate the percent change:

- $\frac{857,425 \text{ people} - 757,278 \text{ people}}{757,278 \text{ people}} \times 100$
- $\left(\frac{857,425 \text{ people}}{757,278 \text{ people}} - 1\right) \times 100$

One point for the correct calculation of the percent change:

1 point

Accept one of the following:

- 13%
- 13.22%
- 13.224602%

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- (ii) Based on Charlotte’s 2019 growth rate of 1.88%, **calculate** the year when the population of Charlotte will double, assuming the growth rate stays the same. **Show** your work. **1 point**

One point for the correct setup to calculate the year the population of Charlotte will double:

- Doubling time = $\frac{70}{1.88} = 37 \text{ years} + 2019$

One point for the correct calculation year the population of Charlotte will double: **1 point**

- 2056

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- (iii) The average Charlotte resident uses 90 gallons of water per day. **Calculate** the gallons of water used by the population of Charlotte in the year 2018. **Show** your work. **1 point**

One point for the correct setup to calculate the gallons of water used in 2018:

- $\frac{90 \text{ gallons of water}}{\text{person per day}} \times 841,611 \text{ people} \times 365 \text{ days}$

One point for the correct calculation of the gallons of water used in 2018: **1 point**

Accept one of the following:

- 27,646,921,350 gallons
- 2.76×10^{10} gallons
- 2.8×10^{10} gallons
- 3×10^{10} gallons

Total for part (c) 6 points

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- (d) Drought periods are becoming more frequent in North Carolina, causing water resources to become more scarce. **Describe** one realistic action that citizens could take to reduce domestic outdoor water use. **1 point**

Accept one of the following:

- Plant drought resistant plant species/use artificial landscaping/use xeriscaping to reduce the need for irrigation.
- Eliminate/reduce nonessential usage of water, such as washing of cars, power washing.
- Reduce the use of sprinklers/irrigation by monitoring soil conditions, weather conditions or reducing frequency.
- Collect rainwater or gray water for irrigation.
- Water plants/lawn before sunrise/after sunset to limit evaporation.
- Switch to drip irrigation to limit evaporation.

Total for part (d) 1 point

Total for question 3 10 points