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

(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**

(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.

(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

(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)

(iv) During the investigation, researchers discovered that some of the land next to one of the **1 point** 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.

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	• 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	• Quick/efficient method to reduce/eliminate pest species
Use manual/mechanical methods to remove plant species	• 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	• 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

(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.

(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**

(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

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| (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%

(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 $= \dfrac{70}{1.88} = 37$ years + 2019

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

- 2056

(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:

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

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**

(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**