AP® Environmental Science
Scoring Guidelines
Set 2

Question 1: Design an Investigation   10 points

(a)	Based on the data in the graph, **identify** the average number of species found in technically restored piles 16–25 years after restoration started.	**1 point**

Accept one of the following:

- 8
- 9

(b)	Based on the data in the graph, **describe** the relationship between the average number of species and age of the spontaneous restoration piles.	**1 point**

Accept one of the following:

- The number of species increases with age of piles.
- The average number of species increases as the years since restoration increase.
- There is a direct/positive relationship/correlation between the two variables.

(c)	Using the data in the graph, **make a claim** that supports or refutes the hypothesis that the number of animal species in the spontaneously restored piles would be higher than the number of animal species in the technically restored piles.	**1 point**

- The spontaneously restored areas support more plant species, which provides habitat, food, and/or shelter for animal species.

(d)	**Describe** a characteristic of a plant species that would have been present in the spontaneous restoration piles from years 1 to 5.	**1 point**

Accept one of the following:

- A description of a characteristic of pioneer or generalist species such as:
    - Able to grow with little/poor soil
    - Able to grow in soil with low organic matter/low nutrients
    - Able to grow in full sunlight
    - Able to colonize an area quickly
    - Able to grow in a wide range of habitats

(e)	**Explain** how the return of plant life would have been altered in the spontaneous piles if the mining had taken place in the tundra rather than in temperate forests.	**1 point**

Accept one of the following:

- It would be slower because it is colder/growing season is shorter/there is less rain.
- It would include plants that are native to the tundra not the temperate forests.
- It would reflect the lower species diversity found in the tundra.

(f)	**Identify** the scientific question for the investigation.	**1 point**

Accept one of the following:

- Does the presence of vegetation affect the amount/appearance of runoff?
- Does the presence of soil covering affect the amount/appearance of runoff?
- Does the presence of different materials affect the amount/appearance of runoff?

(g)	**Identify** a dependent variable in the experiment.	**1 point**

Accept one of the following:

- Water collected
- Runoff volume
- Water appearance

(h)	**Explain** how the results of the experiment would likely have been altered if the soil had contained a higher percentage of sand, which has the largest particle size of the components of loam.	**1 point**

Accept one of the following:

- The amount/volume of water collected/runoff would decrease because more water would infiltrate into the soil.
- The water collected could be clearer as the sand particles settle faster.

(i)	**Describe** one ecological impact that could result from the drainage from mine waste into nearby waterways.	**1 point**

Accept one of the following:

- Acidic/low pH runoff could be outside the range of tolerance of some species.
- Acidic/low pH runoff could lead to disease/death of some species.
- Heavy metals in runoff can accumulate/biomagnify in wildlife leading to disease/death.
- Soils may run off into nearby waterways and could increase turbidity/sedimentation outside the range of tolerance of some species.
- Soils may run off into nearby waterways and could increase turbidity/sedimentation leading to disease/death.

| **(j)** | **Describe** one strategy to reduce the drainage from mine waste into waterways downstream from mines. | **1 point** |

Accept one of the following:

- Vegetation can be planted, reducing sediments/heavy metals flowing into streams.
- Mine waste can be covered with soil/plastic/concrete.
- Mine waste can be covered with lime or other alkaline substances.
- Mine waste can be removed to another location that cannot run off into waterways.
- Water can be diverted to avoid contact with mining waste.
- Contaminated water can be treated to reduce acidity.
- Contaminated water can be treated to remove heavy metals.
- Mine waste can be disposed underwater.
- Mine waste drainage can be diverted into holding basins.

Total for question 1   10 points

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

(a)	Based on the information given, **identify** a body of water invaded by Asian carp that is labeled on the map.	**1 point**

Accept one of the following:

- Mississippi River
- Lake Erie
- Missouri River
- Ohio River

(b)	Based on the information shown in the map, **describe** the change in the distribution of Asian carp since their introduction in the 1970s.	**1 point**

Accept one of the following:

- They are more widely distributed/found in most of the watershed/in a larger area than they were in the 1970s.
- They have moved up/down the Mississippi river.
- They have moved up the Missouri River/Ohio River.
- They have moved northwest and northeast up the rivers.

(c)	**Describe** one impact the introduction of Asian carp could have on the ecosystem services provided by the Great Lakes region.	**1 point**

Accept one of the following:

- Improved drinking water quality as carp consume algae.
- Decreased recreational opportunities (boating/swimming) from the increased population of carp in the water interfering with activities.
- Decreased fishing due to carp outcompeting native fish species.
- Decreased drinking water quality as carp displace filter feeders like native mussels in the food chain/web.
- Decreased algae population resulting in decreased photosynthesis and increased greenhouse gases/global warming/climate change.
- Decreased algae population resulting in decreased photosynthesis and decreased oxygen production.

(d)	**Propose** a realistic solution to help reduce the spread of the Asian carp from their current distribution.	**1 point**

Accept one of the following:

- Offer incentives for fishers to catch and kill carp.
- Encourage consumption of carp.
- Build fencing/netting between waterways.
- Use shock treatment (dispersal barrier system).
- Create/Use an Asian-carp specific poison/deterrent (carpicide, CO_2, microparticles).
- Implement high-frequency sound deterrent system.
- Prohibit transfer of bait or ballast water from one body of water to another.

(e)	**Justify** the solution proposed in part (d) by providing an additional advantage.	**1 point**

Accept one of the following:

Solution proposed in part (d)	Justification of solution with additional benefit
Build fencing/netting between waterways. Create/Use an Asian-carp specific poison/deterrent (carpicide, CO_2, microparticles). Implement high-frequency sound deterrent system. Use shock treatment (dispersal barrier system).	• Create jobs in the Great Lakes fishing industry. • Little to no harm to native animal/plant populations in watershed. • Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed. • Maintain revenue for existing fishing industry/tourism of Great Lakes.
Encourage consumption of carp.	• Increase revenue in the Great Lakes fishing industry/sale of carp. • Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed. • Provide new food source (domestically/internationally)/combat hunger issues worldwide. • Allow the return of native species resulting from less competition from the Asian carp.

Offer incentives for fishers to catch and kill carp.	- Create jobs in the Great Lakes fishing industry. - Increase revenue from the sale of Asian carp. - Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed. - Provide new food source (domestically/internationally)/combat hunger issues worldwide. - Allow the return of native species resulting from less competition from the Asian carp.
Prohibit transfer of bait or ballast water from one body of water to another.	- No harm to native animal/plant populations in watershed. - Reduce negative impacts carp have on the feeding relationships in the Mississippi/Great Lakes watershed. - Maintain revenue for existing fishing industry/tourism of Great Lakes.

(f)   **Identify** the primary consumer in the Great Lakes food chain.   **1 point**

- Zooplankton

(g)   **Describe** what the arrows in the aquatic food chain represent.   **1 point**

Accept one of the following:

- The flow of energy/energy flow.
- The flow of matter/matter flow.

(h)   **Describe** one possible effect of the introduction of the Asian carp on the Great Lakes food chain.   **1 point**

Accept one of the following:

- There will be fewer zooplankton/macroinvertebrates/yellow perch/rainbow trout.
- There will be less food for other species at the same trophic level on the food chain.
- There will be less food for species that don't eat carp and are higher on the food chain.

(i)	**Describe** one way that overfishing of blue pike illustrates the tragedy of the commons.	**1 point**

Accept one of the following:

- The blue pike are a shared resource that were depleted/went extinct due to unregulated access.
- The blue pike are a common resource that were depleted by fishers, maximizing profits/catching as many as possible.

(j)	One potential solution to reduce overfishing is to use aquaculture. **Describe** one disadvantage of this solution.	**1 point**

Accept one of the following:

- Aquaculture contaminates water with excess organic waste/antibiotics.
- Fish that escape from facilities compete or breed with wild fish.
- Fish in aquaculture facilities can spread diseases to wild fish.
- The high density of fish in aquaculture facilities can lead to increased disease.
- Loss of jobs in the fishing industry.
- Excess pressure on fisheries/wild stocks used to create food pellets.
- Decrease in genetic diversity of farm raised fish.
- Habitat degradation from conversion of ecosystems to fish farms.
- Overuse of antibiotics in farmed fish (create antibiotic resistant bacteria that can be harmful to humans).

Total for question 2   10 points

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

(a)	**Describe** one environmental problem associated with the release of methane into the atmosphere.	**1 point**

Accept one of the following:

- It traps heat effectively leading to climate change/global warming.
- The greenhouse effect is enhanced, increasing global temperatures/warming.
- It is a greenhouse gas, which leads to climate change/global warming.
- It is a greenhouse gas, which leads to melting ice/rising sea levels.

(b)	**Describe** one factor that could affect the decomposition of the solid waste in a landfill.	**1 point**

Accept one of the following:

- The amount of/percentage of organic material in the solid waste.
- The amount of/percentage of non-degradable material in the solid waste.
- Conditions of the landfill (such as concentration of oxygen, population of microbes/decomposers, temperature, moisture).
- Environmental conditions of the area (such as temperature, amount of rainfall, climate, weather, etc.).

(c)	**Propose** a solution to decrease the amount of methane released from landfills into the atmosphere.	**1 point**

Accept one of the following:

- Incinerate waste.
- Compost waste.
- Recycle/reuse non-synthetic organic waste (paper, textiles).
- Install/Use methane collection systems.
- Burn off/Combust the methane coming from the landfill.

(d)   **Justify** the solution proposed in part (c) by describing an additional advantage, other than decreasing the amount of methane released from landfills.   **1 point**

Accept one of the following:

Solution proposed in part (c)	Justification of solution with additional advantage
Incinerate waste.	• Extends the lifetime of the landfill. • Reduces the amount of waste going to the landfill. • Can be used to generate electricity/heat. • Can generate income. • Reduces land area needed for landfills.
Compost waste.	• Extends the lifetime of the landfill. • Produces effective, inexpensive fertilizer. • Reduces land area needed for landfills.
Recycle/Reuse non-synthetic organic waste (paper, textiles, etc.).	• Reduces land needed for landfills. • Reduces energy/resources needed for new products. • Reduces trees cut for new paper.
Install/Use methane collection systems. Burn off/Combust the methane coming from the landfill.	• Can be used to generate electricity. • Can be used to heat buildings. • Can generate income. • Can be used as fuel. • Reduces the need for other energy sources.

(e)	The average cow releases 150 liters of methane per day. **Calculate** the amount of methane that was released by all beef cattle raised in the United States in one year. **Show** your work.	**1 point**

One point for the correct setup to calculate the amount of methane released in one year:

Accept one of the following:

- $\dfrac{150 \text{ L methane per day}}{\text{cow}} \times 31,200,000 \text{ cows (cattle)} \times \dfrac{365 \text{ days}}{1 \text{ year}}$

- $31,200,000 \times \dfrac{150 \text{ L}}{\text{cow}} \times 365 \text{ days}$

- $150 \times 31,200,000 \times 365$

One point for the correct calculation of the amount of methane released in one year:	**1 point**

Accept one of the following:

- 1,708,200,000,000 L
- 1.7×10^{12} L

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

(f)	A typical beef cow needs 11.8 kilograms of food per day and each hectare of cattle pasture produces 26.2 kilograms of grasses. **Calculate** the number of hectares of pasture that would be needed to support all beef cattle raised in the United States for one day. **Show** your work.	**1 point**

One point for the correct setup to calculate the number of hectares of pasture to support cattle:

Accept one of the following:

- $\dfrac{11.8 \text{ kg}}{\text{cow}} \times \dfrac{1 \text{ ha}}{26.2 \text{ kg}} \times 31,200,000 \text{ cows (cattle)}$

- $31,200,000 \times \dfrac{11.8 \text{ kg}}{26.2 \text{ kg}}$

- $\dfrac{11.8}{26.2} \times 31,200,000$

One point for the correct calculation of the number of hectares of pasture to support cattle:	**1 point**

Accept one of the following:

- 14,051,908
- 1.4×10^7
- 14.1 million

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

(g)   The average American consumes 2,250 kilocalories of food per day. Beef cattle can   **1 point**
produce 2.7 million kilocalories per hectare of land. Corn can produce 30.4 million
kilocalories per hectare of land. **Calculate** how many more American people could be fed if
150 hectares of land was used to grow corn instead of raising beef cattle. **Show** your work.

One point for the correct setup to calculate the change in the number of people:

Accept one of the following:

- $\dfrac{(30,400,000 \text{ kcal} - 2,700,000 \text{ kcal})}{1 \text{ ha}} \times \dfrac{1 \text{ person}}{2,250 \text{ kcal}} \times 150 \text{ ha}$

- $(30,400,000 - 2,700,000) \times \dfrac{1 \text{ person}}{2,250 \text{ kcal}} \times 150$

- $\left(\dfrac{30,400,000}{2,250} \times 150\right) - \left(\dfrac{2,700,000}{2,250} \times 150\right)$

- $\dfrac{(30,400,000 - 2,700,000)}{2,250} \times 150$

One point for the correct calculation of the change in the number of people: **1 point**

Accept one of the following:

- 1,846,667
- 1.8×10^6

Total for part (g)	**2 points**
Total for question 3	**10 points**