AP® Environmental Science
Scoring Guidelines
Set 2
### Question 1: Design an Investigation 10 points

<table>
<thead>
<tr>
<th>(a) (i)</th>
<th><strong>Identify</strong> the scientific question that resulted in the data presented in the graph. 1 point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accept one of the following:</td>
</tr>
<tr>
<td></td>
<td>• What is the relationship between slope and annual erosion rate for four different land use types?</td>
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<tr>
<td></td>
<td>• Does crop rotation/tilling/not tilling/using cover crops on various slopes increase/decrease/change erosion rates?</td>
</tr>
<tr>
<td>(ii)</td>
<td><strong>Identify</strong> the agricultural practice that could be used on a 15% slope without leading to a higher than tolerable loss of soil. 1 point</td>
</tr>
<tr>
<td></td>
<td>• Crop rotation</td>
</tr>
<tr>
<td>(iii)</td>
<td><strong>Describe</strong> the effect of adding a cover crop compared to using the no-till method. 1 point</td>
</tr>
<tr>
<td></td>
<td>Accept one of the following:</td>
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<tr>
<td></td>
<td>• Adding a cover crop reduces the annual rate of soil erosion compared to using the no-till method.</td>
</tr>
<tr>
<td></td>
<td>• Adding a cover crop allows planting on greater sloped land before reaching tolerable loss as compared for the no-till method.</td>
</tr>
<tr>
<td>(iv)</td>
<td><strong>Identify</strong> one natural mechanism of soil erosion. 1 point</td>
</tr>
<tr>
<td></td>
<td>Accept one of the following:</td>
</tr>
<tr>
<td></td>
<td>• Moving/flowing water</td>
</tr>
<tr>
<td></td>
<td>• Rainfall</td>
</tr>
<tr>
<td></td>
<td>• Wind</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>(b) (i)</th>
<th><strong>Identify</strong> the dependent variable stated in the hypothesis. 1 point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accept one of the following:</td>
</tr>
<tr>
<td></td>
<td>• The amount of sediment discharge</td>
</tr>
<tr>
<td></td>
<td>• The amount of sediment run-off</td>
</tr>
<tr>
<td>(ii)</td>
<td><strong>Describe</strong> one way to add a control to improve the design of the study. 1 point</td>
</tr>
<tr>
<td></td>
<td>Accept one of the following:</td>
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<tr>
<td></td>
<td>• Add a plot that is bare/does not have straw bales or grass (no ground cover).</td>
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<tr>
<td></td>
<td>• 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).</td>
</tr>
</tbody>
</table>
(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

(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

(i) Identify what biome this range most likely represents.  
- Tropical Rainforest

(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.

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).

(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

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

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.

Accept one of the following:

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

1 point
(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:

<table>
<thead>
<tr>
<th>Legislation identified in (d)(i)</th>
<th>Explanation of requirements that specifically protect species threatened by extinction</th>
</tr>
</thead>
</table>
| • 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.

Accept one of the following:

<table>
<thead>
<tr>
<th>Solution proposed in (e)(i)</th>
<th>Justification of how solutions offer potential advantages, other than frog protection</th>
</tr>
</thead>
</table>
| • 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

<table>
<thead>
<tr>
<th>(a)</th>
<th>Describe why coal is considered a nonrenewable energy source.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accept one of the following:</td>
</tr>
<tr>
<td></td>
<td>• Nonrenewable energy sources like coal exist in a fixed/finite/limited amount.</td>
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<tr>
<td></td>
<td>• The formation rate of coal is less than the consumption/combustion rate of coal.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(b)</th>
<th>Describe one potential environmental advantage of replacing a coal-fired power plant with a natural-gas power plant.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accept one of the following:</td>
</tr>
<tr>
<td></td>
<td>• Natural gas combustion emits fewer greenhouse gases/less CO₂.</td>
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<tr>
<td></td>
<td>• Natural gas combustion does not emit mercury/lead/cadmium/uranium.</td>
</tr>
<tr>
<td></td>
<td>• Natural gas combustion emits less NOₓ/SO₂/reduces acid precipitation.</td>
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<tr>
<td></td>
<td>• Natural gas combustion produces less/no particulate matter/soot/smog.</td>
</tr>
<tr>
<td></td>
<td>• Transport of natural gas destroys/fragments less habitat or requires less fossil fuel use than transport of coal.</td>
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<tr>
<td></td>
<td>• Habitat destruction due to the impoundment of coal ash or coal slurry is negated.</td>
</tr>
<tr>
<td></td>
<td>• Coal extraction destroys habitat by strip mining or mountaintop removal.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(c)</th>
<th>Describe one economic advantage of using natural gas, rather than coal, in producing electricity.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Accept one of the following:</td>
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<td></td>
<td>• Transport of natural gas (in pipelines) costs less than transport of coal (by rail).</td>
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<tr>
<td></td>
<td>• Natural gas (methane) harvested from a decomposition reaction (landfills, wastewater treatment plants, biodigesters) costs less than coal.</td>
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<tr>
<td></td>
<td>• 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.</td>
</tr>
<tr>
<td></td>
<td>• There are fewer pollution controls needed for a natural gas powerplant, decreasing the cost of operation/construction/permitting.</td>
</tr>
<tr>
<td></td>
<td>• There are lower combustion-residue disposal costs from the operation of natural gas burning powerplants than from coal-burning power plants.</td>
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<tr>
<td></td>
<td>• 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.</td>
</tr>
</tbody>
</table>
(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.

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.

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

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

One point for the correct calculation of the percent change:

- 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.

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

\[
(50,000 \text{ ha} - 43,000 \text{ ha}) \times \frac{2.3 \text{ kg}}{\text{ha}}
\]

\[
50,000 \text{ ha} \times 2.3 \text{ kg/ha} = 115,000 \text{ kg}; 43,000 \text{ ha} \times 2.3 \text{ kg/ha} = 98,900 \text{ kg}
\]

115,000 kg – 98,900 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$_{2.5}$

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.

One point for the correct setup to calculate the increase in hospital admissions:

- $\frac{0.23}{0.10} \times 0.01 \times 7,390$ admissions
- $\frac{0.23}{0.10} \times \frac{1}{100} \times 7,390$ admissions
- $\frac{23}{10\%} \times 1\% \times 7,390$ admissions

One point for the correct calculation of the increase in hospital admissions.

Accept one of the following:

- 169 more admissions
- 170 more admissions

Total for part (g) 2 points

Total for question 3 10 points