

**AP® ENVIRONMENTAL SCIENCE  
2016 SCORING GUIDELINES**

**Question 4**

Soil is a complex mixture of living organisms and organic material, along with minerals and other abiotic components. Soils help sustain life and provide ecosystem functions.

- (a) **Describe** how TWO climate factors affect the rate of soil formation.

*(2 points: 1 point for each correct description of how a climate factor affects the rate of soil formation. Only the first two descriptions can earn a point.)*

| Climate Factor             |      | Effect                                                                                                                                                                                                          |
|----------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Temperature                | High | Increases rates of biological activity (decomposition) and chemical activity – increases rates of soil formation                                                                                                |
|                            | Low  | Decreases rates of biological activity (decomposition) – decreases rates of soil formation<br><br>Increases the rate of weathering (frozen water expands, breaking rock) – increases the rate of soil formation |
| Precipitation/<br>Humidity | High | Increases biological activity and weathering – increases the rate of soil formation<br><br>Increases erosion, runoff – decreases the rate of soil formation                                                     |
|                            | Low  | Decreases biological activity and weathering – decreases the rate of soil formation                                                                                                                             |
| Wind                       |      | Can carry in particles – increases rates of accumulation<br><br>Can hasten rates of soil erosion – decreases rates of accumulation                                                                              |

(Note: No point earned for merely identifying a climate factor.)

- (b) As soils form, distinct layers known as horizons develop over time. One of these is the A horizon.
- Identify** one specific biotic component of the A horizon.
  - Identify** one abiotic component of the A horizon.

*(2 points: 1 point for a correct identification of a specific biotic factor and 1 point for a correct identification of an abiotic factor.)*

| Examples of components include: |                                                                                                                   |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Biotic                          | Humus, microorganisms, bacteria, earthworms, macroinvertebrates, roots, fungi, beetles, decomposers, insects      |
| Abiotic                         | Sand, silt, clay, water, air, nutrients (N,P, K compounds), decomposing parent material, minerals, rocks, pebbles |

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**Question 4 (continued)**

- (c) Nitrate levels exceeding the United States Environmental Protection Agency's primary drinking water standard have been found in the groundwater of areas with intensive agriculture.
- Identify** one agricultural practice that can lead to elevated nitrate levels in groundwater.  
*(1 point for a correct agricultural practice that leads to elevated nitrate levels in groundwater.)*
    - Application of fertilizer
    - Improper sealing of feedlots
    - Improper construction or maintenance of animal waste lagoons
  - Describe** how the practice you identified in (c)(i) leads to elevated nitrate levels in ground water.  
*(1 point for a correct description linked to the practice identified in part (c)(i).)*
    - Nitrates infiltrate/percolate/seep into ground water.
    - Nitrates entering surface waters that recharge aquifers (must connect surface with ground water).
- (d) Acid deposition has affected soil quality in many parts of the northeastern United States.
- Explain** one way acid deposition onto soil can affect plant health.  
*(1 point for a correct explanation of one way acid deposition onto soil can affect plant health.)*
    - Increased soil acidity may be outside of the optimal range of tolerance for the plant, resulting in poor plant growth or death.
    - Acid can leach cations/metal ions/nutrients from soil, making them less available to plants, thus decreasing growth.
    - Aluminum is released and can be toxic to plants.
    - Acid can diminish the ability of soil to buffer, leading to poor plant growth.
    - Increased soil acidity can damage plant root systems, stressing plants.
    - Sulfur and nitrogen from acid deposition can build up to levels toxic to plants (or can fertilize the soils).
  - Describe** one method for remediating soil affected by acid deposition.  
*(1 point for a correct description of a method of remediation.)*
    - Add crushed limestone / lime / marble dust / bone meal / crushed egg shells or oyster shells
- (e) Climate change is causing far-reaching ecosystem changes, including soil degradation in many of the world's biomes. **Describe** TWO ways that climate change can degrade soil.  
*(2 points: 1 point for each correct description of how a change in climate has resulted in soil degradation.)*
- Increased global temperatures and decreased precipitation cause desertification.
  - Increased temperatures lead to increased evaporation of irrigation water, resulting in soil salinization.
  - Increased erosion and/or leaching can result from increased precipitation in certain areas.
  - Increased temperature can lead to faster breakdown of organic matter (less organic matter in the soil).
  - Increased temperatures and shifting climatic belts result in longer growing seasons, which can deplete nutrients from the soil.
  - Rising sea levels can result in flooding of coastal areas, leading to salinization of soil and increased soil erosion.
  - Increased temperatures can lead to soil desiccation.