AP® Environmental Science 2016 Scoring Guidelines

AP® ENVIRONMENTAL SCIENCE
2016 SCORING GUIDELINES

Question 1

Read the following article from the *Fremont New Tribune*.

(a) Diseases can devastate populations; however, most diseases do not drive their host to extinction. **Provide** one explanation for why diseases seldom cause extinction.

(1 point for a correct explanation for why diseases seldom cause extinction)

- Genetic diversity in wild populations enables some resistant organisms to survive and reproduce.
- Disease organisms often co-evolve with their hosts, allowing the host to evolve adaptations that resist the disease.
- Disease organisms/pathogens that cause the extinction of their host population jeopardize their own survival.
- Initial deaths thin (reduce density of) populations and make the disease less likely to spread.

(b) Dr. Serach suggests that even if the impact of WNS on little brown bat populations can be reduced and the extinction of the species avoided, the bat populations are likely to remain alarmingly small.

(i) **Describe** TWO threats (other than WNS) to the survival of the bat species if the total number of bats becomes very small.

(2 points: 1 point for each description of a threat. Only the first two descriptions can earn a point.)

- Difficulty finding mates when populations are small, widely dispersed, or have a skewed sex ratio
- Competition from other species with a similar niche (e.g., nesting sites, food)
- Problems associated with a reduction of genetic diversity (small gene pool, lack of hybrid vigor, diseases that affect one will affect all members of the population, bottle-neck, etc.)
- Susceptibility to reduced fitness as a result of decreased protection by the group (e.g., not enough individuals to create heat, less protection by group members, increase in probability of becoming prey without the advantage conferred by group size)
- Increased vulnerability to environmental disturbances (need to name specific disturbance)

(ii) If the little brown bat species does not become extinct and can potentially recover, the rate of recovery is likely to be slow. **Discuss** one aspect of bat biology that might slow the recovery of little brown bat populations to pre-WNS numbers.

(1 point for a correct discussion of a correct aspect of bat biology that might slow their recovery)

- Low fecundity/ few babies per year
- Long generation times in bats
- Advanced age at first reproduction
- Increased parental care

(c) Bats are found in ecosystems around the world. **Describe** TWO ways in which other organisms in an ecosystem could be affected by a decline in a bat population.

(2 points: 1 point for each correct description. Only the first two descriptions can earn a point.)

Question 1 (continued)

- Increase in bat food sources.
- Increase in West Nile and other insect-borne diseases
- Decrease in the spread of rabies
- Decrease in fungus that causes WNS
- Decrease in bat guano (tied to organism)
- Decline in plants pollinated or dispersed by bats
- Decline in bat predators due to decreased food supply.
- Increase in numbers of animals with similar food and habitat needs
- Causes a trophic cascade

(d) The Eastern deciduous forest, in which the little brown bats live, is an important ecosystem. **Identify** TWO ecosystem services that forests provide, and **explain** how each service benefits human society.

(2 points: 1 point for each correct ecosystem service with an explanation of how the service benefits human society)

Acceptable responses may include the following:

Ecosystem Service	Benefit to Humans
Resource material (tree/forest)	Lumber, building materials, fuel, paper, food
Oxygen production	Human respiration
Soil formation/protection	Forestry, agriculture, flood control, water quality
Protection of water supplies	Drinking water, recreation, irrigation, fishing
Habitat (e.g. specify shade, temperature moderation, etc.)	Animals or plants desired by humans for fishing, hunting, food
Biodiversity	Food, medicine, gene diversity, breeding stock
Carbon sink (sequestering)	Slows climate change
Aesthetics/cultural/social	Connection with nature (inspiration for art, music, poetry, etc.), research, education, recreation, tourism

WNS is an emerging disease in bats. Humans are also subject to emerging diseases, such as Ebola. A recent study suggests that the number of emerging infectious diseases affecting human populations has been steadily increasing in recent decades.

(e) **Provide** a likely reason for the increase in emerging infectious diseases affecting human populations. Include an explanation for the reason you provided.

(2 points: 1 point for a correct reason for the increase in emerging infectious diseases. 1 point for a correct explanation of how the reason likely increases the emerging diseases affecting human populations.)

Acceptable responses may include the following:

Question 1 (continued)

Reason for Increase	Explanation
Climate change, global warming	Allows pathogens and disease vectors to survive in places that were previously too cold or dry
Increase in global travel	Increased likelihood of contracting/spreading disease
Increased exposure to animals (zoonotic)	Changes in agricultural practices increase rodents, etc; trade in exotic species, intrusion into wild habitats, urban sprawl
Increase in population density/distribution	Increased likelihood of contracting /spreading disease from others
Lack of vaccinations	Increase human susceptibility to disease, reduce herd immunity
Antibiotic resistance	New disease strains evolve
Decrease in medical care/public health	Poverty, war, migration, human behavior (refusing to use condoms/sharing needles/refusing aid)

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Question 2

(a) Use the data below to respond to the following. For each calculation, show all your work.

(i) **Calculate** the weight (in tons) of rock waste produced globally each year when iron ore is converted to pig iron.

(1 point for the correct answer with work shown)

1.6 billion tons of iron ore – 1.2 billion tons of pig iron = 0.4 billion tons of waste

OR

$1.6 \times 10^9 - 1.2 \times 10^9 = 4 \times 10^8$

(ii) **Calculate** the weight (in tons) of pig iron that could be produced if all of the estimated global iron ore reserves were used for pig iron production.

(2 points: 1 point for the correct setup and 1 point for the correct answer)

$\frac{1.2 \text{ billion tons pig iron}}{1.6 \text{ billion tons iron ore}} \times 800 \text{ billion tons iron ore} = 600 \text{ billion tons iron}$

OR

$\frac{1.2}{1.6} = 0.75 \qquad 0.75 \times 800 \text{ billion} = 600 \text{ billion} \qquad \textbf{OR} \qquad \frac{1.2}{1.6} = \frac{x}{800}$

OR

$\frac{1.2 \times 10^9}{1.6 \times 10^9} \times 8.0 \times 10^{11} = 6.0 \times 10^{11}$

(iii) **Calculate** the weight (in tons) of the current global iron ore reserves that would be used to make steel if the current trends continue.

(1 point for the correct answer with work shown)

0.95×800 billion tons of iron = 760 billion tons iron ore used to make steel

OR

$0.95 \times 800 = 760$ billion

OR

$9.5 \times 10^{-1} \times 8 \times 10^{11} = 7.6 \times 10^{11}$

(b) **Calculate** the weight (in tons) of coal that is conserved each year in North America by recycling steel.

(1 point for a correct answer with work shown)

$\frac{0.7 \text{ fewer tons coal used}}{1 \text{ ton steel recycled}} \times 80 \text{ million tons steel recycled} = 56 \text{ million tons coal saved per year in North America}$

OR

$0.7 \times 80 = 56$ million

OR

$7.0 \times 10^{-1} \times 8.0 \times 10^7 = 5.6 \times 10^7$

Question 2 (continued)

(c) **Describe** TWO environmental problems that are associated with abandoned coal mine sites.

(2 points: 1 point for each correct description of an environmental problem. Only the first two descriptions can earn a point.)

- Subsidence/sinkholes as shafts collapse
- Habitat destruction/slow to recover
- Stream/water quality degradation
- Acid mine drainage
- Heavy metal runoff
- Tailings alter landscape and drainage patterns
- Increased soil erosion
- Particulate/dust pollution
- Animals fall in
- Methane release
- Underground fires difficult to extinguish

(d) **Describe** one method that can be used to mitigate one of the problems you identified in part (c).

(1 point for a correct description of a mitigation method for one of the two environmental problems described in part (c))

- Plant trees or other plants to restore cover/reduce erosion
- Fill in/fence off abandoned shafts to stop subsidence or reduce access
- Prevent acid mine drainage and leaching from sites using retaining ponds, berms, other BMPs
- Treat acid mine drainage with limestone
- Return tailings to excavation sites
- Recontour the land
- Place gravel on surface to reduce wind erosion

(e) **Discuss** one reason why surface coal mining is generally less expensive than subsurface mining.

(2 points for correct identification of a reason linked with a discussion of why surface mining is less expensive)

Reason	Economic Discussion
Wages	Fewer workers needed above ground Workers paid less above ground
Healthcare	Workman's compensation Insurance
Safety	Increased likelihood below ground of ○ severe accidents ○ death ○ black lung
Legal costs	Lawsuits from injuries, accidents, rescues

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Question 3

Municipal solid waste (MSW) is the trash collected from households and businesses.

(a) Use the data provided in the graph to respond to the following.

(i) **Explain** one probable cause (other than increased composting) for the change in per capita waste generation from 2000 to 2012.

(1 point for a correct explanation for the change in per capita generation from 2000 - 2012)

- People or businesses practicing one of the following: refuse, reduce, reuse, recycle, or repurpose.
- Lighter materials contribute to less MSW creation (e.g. plastic bottles not glass bottles)
- Less material used in products (newspapers smaller, aluminum cans less massive)
- Technology reduces waste generation (e.g., reading magazines online → less paper)
- Economic recession → less consumption → less MSW produced

(ii) **Calculate** the percent increase in total MSW generation from 1980 to 2012.

(1 point for the correct answer with work shown)

$$\frac{(250 \text{ million tons} - 150 \text{ million tons})}{150 \text{ million tons}} \times 100 = 66\% \text{ to } 67\%$$

(b) Two ways of managing MSW are incineration and disposal in landfills.

(i) **Identify** one disadvantage of waste incineration.

(1 point for a correct identification of a disadvantage of waste incineration)

- Specific air pollutant (e.g., CO, CO_2, dioxin, halogens, particulates, SO_x, NO_x)
- Ash disposal necessary
- Incinerator is expensive to construct and/or operate
- MSW supply and quality may be limited requiring additional fuel
- Reduced quality of life and property value due to incinerator and supply trucks

(ii) **Identify** one disadvantage of waste disposal in landfills.

(1 point for a correct identification of a disadvantage of waste disposal in landfills)

- Ground water, surface water, or soil contamination through some transport mechanism
- Reduced quality of life and property value due to landfill and supply trucks
- Release of methane or CO_2
- Odor source
- Attracts vermin
- Habitat destruction
- Preclusion of other land uses
- Explosion/seepage hazard from methane produced

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Question 3 (continued)

Trash incineration is one way to generate electricity from MSW. Electricity can also be generated from waste buried in landfills.

(c) **Describe** the specific steps of a process use to produce electricity from waste buried in a landfill.
(3 points – 1 point for each step in the process of generating electricity from landfill gas)

Step	Description of Step
Acquire fuel (chemical energy)	Methane collected or gathered
Use fuel (chemical → mechanical)	Fuel is combusted to produce steam or hot air
Generate electricity (mechanical → electricity)	Steam or hot air spins/turns/rotates a turbine/generator to generate/produce electricity

(d) Many landfills do not accept used tires. As a result, the tires are often dumped in poorly regulated piles. **Describe** one human health problem associated with piles of discarded tires.
(1 point for a correct description of a human health problem associated with piles of discarded tires)

- Discarded tires provide habitat for mosquitoes/pests that can be disease vectors.
- Tires may catch fire and release air pollutants that cause respiratory issues in humans.

(e) Composting is one way to reduce the amount of waste that enters a landfill.

(i) Other than reducing the volume of waste, **identify** one advantage of composting.
(1 point for a correct identification of an advantage of composting)

- The resulting compost can be used or sold as fertilizer or soil amendments.
- Municipal composting facilities may provide jobs.
- MSW may emit less foul odor if organic material is composted.
- Tipping fees and trash removal costs may be reduced due to removal of dense compostable material.

(ii) **Identify** one disadvantage of composting.
(1 point for a correct identification of a disadvantage of composting)

- Compost may attract undesirable animals (vermin).
- Compost may emit foul odors or spontaneously combust.
- Nutrients released from decomposing organic matter may run off into surface waters and cause water quality problems.
- Compost may release methane.
- Composting organic material requires a great investment of time and labor by humans.

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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 – inceases rates of soil formation
	Low	Decreases rates of biological activity (decomposition) – decreases rates of soil formation Increases the rate of weathering (frozen water expands, breaking rock) – increases the rate of soil formation
Precipitation/ Humidity	High	Increases biological activity and weathering – increases the rate of soil formation 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 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.
(i) **Identify** one specific biotic component of the A horizon.
(ii) **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.

(i) **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

(ii) **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.

(i) **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).

(ii) **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.