

Question 1: Design an Investigation**10 points**

(a) Identify the control group in this experiment.

1 point

Accept one of the following:

- Plot D
- Unmodified beans

(b) Identify the scientific question for the investigation.

1 point

Accept one of the following:

- Will genetically modified green beans have higher crop yields than unmodified green beans?
- Is there a difference between the crop yields of genetically modified and unmodified green beans?
- Does genetically modifying green beans affect crop yield?

(c) Researchers repeated the experiment modifying the length of time for the spray irrigation to 20 minutes per day. **Explain** how the results of the experiment could be altered with this modification.

1 point

Accept one of the following:

- With less water, there will be lower crop yield/fewer green beans harvested in all plots.
- The genetically modified beans will remain similar in yield because they are resistant to drought/need less water, but the unmodified beans will decrease in crop yield because they will receive less water.

(d) Based on the data in the table, **identify** the plot with the lowest soil temperature.

1 point

Accept one of the following:

- Plot D
- The unmodified green beans

(e) **Describe** how sediment runoff and fertilizer runoff compare between the unmodified green beans and the genetically modified green beans.

1 point

Accept one of the following:

- Both types of runoff/Sediment and fertilizer (phosphorus/nitrogen) runoff are lower with the genetically modified beans.
 - Both types of runoff/Sediment and fertilizer (phosphorus/nitrogen) runoff are higher with the unmodified beans.
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- (f) The Type 2 GMO beans in Plot B were developed to grow more quickly than the unmodified beans in Plot D. Researchers have hypothesized that the Type 2 beans would use fertilizer more completely than the other varieties. Based on the data in the table and the experimental design, **explain** whether the researchers' hypothesis was supported or refuted. **1 point**

Accept one of the following:

- The hypothesis is supported because there is less fertilizer (phosphorus/nitrogen) in the runoff from plot B, so the beans in plot B are absorbing/taking up more fertilizer (phosphorus/nitrogen).
- The hypothesis is supported because there is more fertilizer (phosphorus/nitrogen) in the runoff from plot D, so the beans in plot D are absorbing/taking up less fertilizer (phosphorus/nitrogen).
- The hypothesis is supported because the plants in plot B were able to produce more beans given the same amount of fertilizer.

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- (g) **Describe** the ecological process that occurred on the plots after the crops were burned. **1 point**

Accept one of the following:

- Fast growing/early successional organisms returned to/colonized the soil after the fire/major disturbance.
- Secondary succession occurred where plants recolonize a habitat after the fields were burned/after a major disturbance.

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- (h) After each flooding event, the plot with twice the plant diversity returned to its prior level of biodiversity more quickly than the other plots did. **Explain** why a community with more plant diversity will recover more quickly from the flooding. **1 point**

Accept one of the following:

- The plot with higher diversity/richness has more species/organisms, so the floods harm a smaller proportion of the species/organisms.
 - The plot with higher diversity/richness has more connections between organisms, so the floods disrupt a smaller percentage of the connections between organisms.
 - The plot with higher genetic diversity within species may have more flood tolerant individuals that will survive a flood.
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- (i) After the last flooding event, a beetle not previously known in the area appeared in one of the plots with less plant diversity. Over a period of a few months, the new beetle population increased, whereas the existing beetle species in the plot had declining populations. **Explain** why the new beetle species could be better able to successfully populate this plot than the existing beetle species could. **1 point**

Accept one of the following:

- The new beetle is a generalist/r-selected species and could more quickly populate the area/outcompete the existing/native beetle species.
- The flooding of the plot caused a natural disruption to the existing community, eliminating species/natural predators and opening niches for the new/invasive beetle.
- Low diversity communities are susceptible to disruption and can't recover allowing the new/nonnative beetle species to invade
- The new beetle is an invasive species that can live outside its normal environment and threaten native species

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- (j) **Describe** one realistic method to prevent the new beetle from spreading beyond the experimental plot. **1 point**

Accept one of the following:

- Remove beetles by trapping/physical removal to reduce their population size.
- Apply a chemical/pesticide to kill beetles.
- Add a predator/parasite/pathogen/biological control that harms beetles.

Total for question 1 10 points

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.
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- (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) (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

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- (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.

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- (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

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- (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

- (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 = $\frac{70}{1.88} = 37 \text{ years} + 2019$		
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:		
$\frac{90 \text{ gallons of water}}{\text{person per day}} \times 841,611 \text{ people} \times 365 \text{ days}$		
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

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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)

- | | |
|---|---|
| <ul style="list-style-type: none"> • Low fecundity/ few babies per year • Long generation times in bats | <ul style="list-style-type: none"> • 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.)

2016 SCORING GUIDELINES

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:

2016 SCORING GUIDELINES**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)

SCORING GUIDELINES

Question 2

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

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)

$$1.6 \text{ billion tons of iron ore} - 1.2 \text{ billion tons of pig iron} = 0.4 \text{ billion tons of waste}$$

OR

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

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

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

OR

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

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)

$$0.95 \times 800 \text{ billion tons of iron} = 760 \text{ billion tons iron ore used to make steel}$$

OR

$$0.95 \times 800 = 760 \text{ billion}$$

OR

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

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

$$0.7 \times 80 = 56 \text{ million}$$

OR

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

SCORING GUIDELINES

Question 2 (continued)

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

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

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

SCORING GUIDELINES

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) | • MSW supply and quality may be limited requiring additional fuel |
| • Ash disposal necessary | • Reduced quality of life and property value due to incinerator and supply trucks |
| • Incinerator is expensive to construct and/or operate | |

(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 | • Release of methane or CO |
| • Reduced quality of life and property value due to landfill and supply trucks | • Odor source |
| | • Attracts vermin |
| | • Habitat destruction |
| | • Preclusion of other land uses |
| | • Explosion/seepage hazard from methane produced |

SCORING GUIDELINES

Question 3 (continued)

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

Describe the specific steps of a process used 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.

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 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.