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# AP Environmental Science

## Sample Student Responses and Scoring Commentary

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# AP<sup>®</sup> ENVIRONMENTAL SCIENCE

## 2018 SCORING GUIDELINES

### Question 1

Read the following article from the *Fremont Daily Times* and answer the questions that follow.

(a) The students want to reduce the school's carbon footprint.

(i) **Define** carbon footprint.

(1 point for correct definition of carbon footprint)

- The amount of carbon dioxide and/or other carbon compounds released to the environment by a product, process, or activity
- A measurement of the amount of carbon released by human activities

(ii) **Identify** one way the school's heating system is likely adding to the school's carbon footprint.

(1 point for correct identification of a way the school's heating system is adding to its carbon footprint)

- The burning/combustion of fossil fuels releases carbon dioxide
- The incomplete combustion of fossil fuels releases carbon monoxide

(iii) **Describe** one realistic way to reduce the contributions of the heating system to the school's carbon footprint

(1 point for correct description of a realistic way to reduce the contributions of the heating system)

- Switch to renewables (solar, wind, etc.)/switch to a more efficient fossil fuel (natural gas, propane)/switch to a provider that uses nuclear energy.
- Decrease the temperature/thermostat in the school during the winter/program thermostat to lower energy consumption during certain times.
- Purchase credits through environmental agencies for carbon-offsetting projects.
- Increase insulation or implement other efficiency/design methods to reduce energy demand (green roof, double paned glass, south-facing windows for passive solar heating, change air filters, etc.).

(b) **Identify** TWO environmental benefits of a living green roof, such as that suggested by Councilperson Fassler.

(2 points; 1 point for each correct identification of an environmental benefit of a green roof)

- Insulation/reduced use of fossil fuels for heating and/or cooling
- Habitat for wildlife and/or plants/increases biodiversity
- Area to grow crops/production of food locally
- Reduction in the number of heat islands in the environment/urban heat island mitigation
- Photosynthesis/carbon capture/CO<sub>2</sub> storage/oxygen release
- Stormwater treatment/runoff reduction
- Filters particulates, VOCs, O<sub>3</sub> from air

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## 2018 SCORING GUIDELINES

### Question 1 (continued)

- (c) **Describe** TWO practices the cafeteria’s food service could use to decrease the environmental impacts of Fremont High School.

(2 points; 1 point for each correct description of a practice that decreases the environmental impact of the school)

- Offer more vegetarian options/serve fewer animal products, etc. to reduce impact from meat production.
- Use some locally sourced food to reduce transportation.
- Grow food at the school to reduce transportation.
- Compost food waste to reduce the amount disposed in landfills.
- Donate leftover food to reduce food waste.
- Use energy-friendly practices (LED lighting, serve more cold-cut sandwiches, etc.) to decrease energy use.
- Purchase bulk packaged items to reduce material waste.
- Use recyclable food containers/don’t use disposable straws/food containers/trays to reduce material waste.
- Install a water fountain/stop selling single-serving water bottles to reduce material waste.
- Use reusable take-out containers/offer savings or credit for reusing containers to reduce material waste.
- Allow students to choose appropriate portions to reduce food waste.
- Purchase organic foods to reduce pesticide use.
- Use grey water to irrigate landscaping to reduce potable water use.

- (d) **Discuss** TWO benefits of using native plants for landscaping at Fremont High School.

(2 points; 1 point for each correct discussion of benefits of using native plants)

- Native plants require less pesticides because they are better adapted to their environment.
- Native plants require less fertilizer because they are better adapted to their environment.
- Native plants require less irrigation water because they are better adapted to their environment.
- Native plants increase biodiversity by providing native habitat areas.
- Native plants support native food webs/native food production by providing native habitat areas.
- Native plants reduce the amount of land available for the establishment/spread of invasive species.
- Native plants save the school money by requiring less water/fertilizer/pesticides/upkeep.

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## 2018 SCORING GUIDELINES

### Question 1 (continued)

- (e) During the renovation, the carpeting must be replaced. **Discuss** one environmental benefit of using flooring made of plant material, such as cork or bamboo, instead of carpet made of synthetic fibers.

(1 point for correct discussion of benefits of using flooring made of plant material)

- Plant-based material is more easily compostable/is biodegradable/can be reused/repurposed, unlike carpet.
- Plant-based material is from a renewable resource making it more sustainable than carpet. Plant-based material is a carbon sink/reservoir, so growing plant materials removes CO<sub>2</sub> from the atmosphere, unlike carpet.
- Plant-based materials require less fossil fuels/toxic chemicals for production than synthetic fibers found in carpets.
- Plant-based materials produce less indoor pollutants (off-gas pollutants/VOCs/release toxins) than carpet.
- Plant-based materials harbor fewer pathogenic vectors/diseases/allergens (fleas, ticks, dust mites, mold spores, etc.) than carpets.
- Plant-based material when cultivated provides habitat for native species.

## PAGE FOR ANSWERING QUESTION 1

a(i) - A carbon footprint is a measure of the amount of Carbon dioxide and ~~out~~ other carbon compounds released by various human activities

a(ii) - The heating system of the school is adding to the carbon footprint because it relies on burning fossil fuels. The burning of fossil fuels releases  $\text{CO}_2$  and other compounds into the air which adds to the carbon footprint.

a(iii) - One realistic way to reduce the heating system's footprint is to install better insulation. By installing better insulation less heat is required to keep a room at a warmer temperature. Therefore less fuel is used to heat and reduces the carbon footprint.

b. - One environmental impact of a green roof is that it reduces the need for cooling and heating because of its insulative properties. Another impact would be that it will increase biodiversity in the area and provide shelter and food for wild birds.

c. - The cafeteria could source all its food from within 50 miles of its production to reduce the amount of  $\text{CO}_2$  released by shipping. The cafeteria could also utilize reusable ~~plates~~ <sup>plates</sup> and silverware to reduce the trash waste from the school.

d. - One benefit to using native plants would be that it would not need fertilizers or increased irrigation because it is ~~designed~~ <sup>designed</sup> to thrive in the existing environmental conditions. Another benefit to using native plants is that it gives shelter and food to wildlife such as deer and birds which ~~the~~ helps with biodiversity.

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## ADDITIONAL PAGE FOR ANSWERING QUESTION 1

e- An environmental benefit to using wooden paneling made of bamboo or cork is that it is a renewable resource. The benefit is that the material is made of fast-growing plants which are easier to regrow which makes it better than synthetic carpetings because the synthetics are made of petroleum products which are not renewable.

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## PAGE FOR ANSWERING QUESTION 1

a) Carbon footprint is the measure of the amount of carbon compounds, such as carbon dioxide, that are released by human activities. The school's heating system is supplied by fossil fuel combustion, which releases carbon dioxide emissions when burning fossil fuels; this adds to the school's carbon footprint. The school can reduce the contribution of the heating system to the school's carbon footprint by utilizing other methods to obtain heat that don't release as much carbon dioxide emissions. An example would be replacing the fossil fuel combustion system with a renewable energy source, such as wind — through a wind turbine, wind turns turbines that then generate electricity which can be used as a heating source. Using wind has a significantly smaller release of carbon compounds compared to fossil fuel combustion, thus reducing the school's carbon footprint.

b) A living green roof provides a habitat for organisms. For example, the green roof can contain species of plants that attract insects such as bees who can pollinate and thrive/survive from the plants on the roof. Another benefit of a living green roof is that there would be more photosynthesizing plants removing carbon dioxide from the atmosphere — this would

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## ADDITIONAL PAGE FOR ANSWERING QUESTION 1

help to reduce the amount of greenhouse gases (carbon dioxide) in the atmosphere.

c) The cafeteria's food service can rely on serving food that belongs on lower trophic levels to help decrease environmental impacts of the school. By serving food on these lower levels, there is less energy being put into producing the food and less resources needed to grow the food (serving food on higher trophic levels—such as cattle—require more resources like water and crops in order to feed and sustain that cattle). Another practice would be for the school to rely on organic food that did not use fertilizers or pesticides in its production process. This would reduce the amount of persistent pesticides that accumulate in the environment or fertilizer nutrients that runoff from farms producing the food (the runoff can impact the environment by contaminating surface water sources).

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## ADDITIONAL PAGE FOR ANSWERING QUESTION 1

d) Using native plants are beneficial because they provide a habitat for naturally occurring organisms in that area that are used to those plants. It provides an ecosystem for insects that are naturally living in that area. They are also beneficial because since native plants have native predators, their population sizes will not go beyond its capacity or to a level where it can harm the habitat.

e) Flooring made of plant material is more environmentally beneficial because in order to create synthetic fibers for carpeting, chemicals/toxins are used. These toxins can then be released into the environment and damage habitats. Producing plant material flooring uses less of these chemicals in the process, being more environmentally safe.

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## PAGE FOR ANSWERING QUESTION 1

A) Carbon footprint is defined as the measure of the amount of carbon dioxide ( $\text{CO}_2$ ) and other compounds released by various human activities

ii) The school's heating system is powered by the combustion of fossil fuels. Fossil fuels, which are used to create energy, create a large amount of carbon dioxide upon combustion. This is why students want to renovate the heating system, to reduce the carbon footprint of the school.

iii) The school could use renewable alternative energy sources to reduce its carbon footprint. This includes solar, wind, or hydroelectric energy. If the school were to use these as its main source of energy, much less  $\text{CO}_2$  would be released.

b) Not having to obtain ~~the~~ fossil fuels is a benefit. When we frack to obtain oil and natural gas, or mine to obtain coal, we sometimes disturb the land by the destruction of various land habitats. Another environmental benefit of a living green roof is the severely reduced emissions of greenhouse gases. These gases, including  $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{SO}_2$  and many others are released in large quantities when fossil fuels are burned to acquire electricity/thermal energy. Because of this heating system, the emission of greenhouse gases could be reduced, which would reduce the rate of the

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## ADDITIONAL PAGE FOR ANSWERING QUESTION 1

greenhouse effect.

C) The school's cafeteria could ~~purchase~~ <sup>purchase</sup> foods that were locally grown. This way, less gasoline would be needed to be burned to transport the food from another region. This would greatly reduce greenhouse gas emissions. Another practice the cafeteria service could use is buying foods from farms that did not use ~~extensive~~ many pesticides. This way it would motivate farmers in the school's area to grow crops without the use of pesticides. This is important as pesticides can be washed away by rain in agricultural runoff. If this happens, the pesticides will eventually make their way into larger bodies of water, and may be toxic to organisms in the aquatic ecosystem.

D) Using native plants would ~~increase~~ eliminate the chance of having an invasive species being introduced into this ecosystem. If an invasive species were to be introduced, the unfair competition between it and a native species would endanger the survival of the native species. This would also increase biodiversity as pollinator organisms could eventually live around the school to pollinate different plants at the school.

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## ADDITIONAL PAGE FOR ANSWERING QUESTION 1

E) Using flooring from natural materials is an environmental benefit as the flooring is from a renewable source. Bamboo or cork could easily be renewed by growing, meaning more flooring could be made. The carpet, however, is made from synthetic fibers. These fibers are made from petroleum, which is non-renewable. ~~It is~~ This means that the reduction in use of petroleum-based products may preserve our limited supply of petroleum.

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## 2018 SCORING COMMENTARY

### Question 1

#### Overview

The intent of this question was for students to consider ways to increase the sustainability of Fremont High School by evaluating various initiatives in a potential conversion of an existing building to a green building. Students were asked to read the document provided and to define the term carbon footprint. Students were asked to identify how the school's heating system could be contributing to the carbon footprint and to describe one way to reduce those contributions. These concepts were drawn from the following sections of the course description: V. Energy Resources and Consumption, B. Energy Consumption.

The next part of the question evaluated student understanding of increasing the sustainability of the school. Students were asked to identify environmental benefits of incorporating a living green roof into the design of the new building. Students were asked to describe practices that could decrease the environmental impact in the cafeteria. Students were asked to discuss the benefits of using native landscaping at the school. Students were asked to discuss an environmental benefit of using flooring made of plant material to replace carpeting made of synthetic fibers. The concepts were drawn from the following sections of the course description: IV. Land and Water Use, D. Other Land Use, 4. Land conservation options and 5. Sustainable land-use strategies and V. Energy Resources and Consumption, F. Energy Conservation.

#### Sample: 1A

#### Score: 10

The response earned 3 points in part (a): 1 point in (a)(i) for correctly defining a carbon footprint as the “amount of carbon dioxide ... released by various human activities”; 1 point in (a)(ii) for correctly identifying that “the burning of Fossil [*sic*] fuels releases CO<sub>2</sub>”; and 1 point in (a)(iii) for describing that “to install better insulation ... less heat is required to keep a room at a warmer temperature.” Two points were earned in part (b): 1 point for correctly identifying that a green roof “reduces the need for cooling and heating because of its insulative properties” and 1 point for correctly identifying that a green roof will “increase biodiversity in the area.” The response earned 2 points in part (c). One point was earned for describing that the cafeteria could decrease Fremont High School's environmental impact by sourcing “its food from within 50 miles of its production to reduce the amount of CO<sub>2</sub> released by shipping.” A second point was earned by describing that the cafeteria could “utilize reusable plates and silverware to reduce the trash waste.” The response earned 2 points in part (d): 1 point was earned for discussing that native plants “will not need fertilizers ... because it is designed to thrive in the existing environmental conditions” and 1 point for discussing that native plants “will not need ... increased irrigation because it is designed to thrive in the existing environmental conditions.” The response earned 1 point in part (e) for correctly discussing that using flooring made of plant materials that “is a renewable resource ... the material is made of fast growing plants which are easier to regrow which makes it better than synthetic carpeting because the synthetics are made of petroleum products which are not renewable.”

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## Question 1 (continued)

### Sample: 1B

Score: 8

The response earned 3 points in part (a): 1 point in (a)(i) for correctly defining a carbon footprint as the “amount of carbon compounds ... that are released by human activities”; 1 point in (a)(ii) for correctly identifying that “fossil fuel combustion ... releases carbon dioxide emissions”; and 1 point in (a)(iii) for describing that “replacing the fossil fuel combustion system with a renewable energy source, such as wind ... that then generate[s] electricity which can be used as a heating source.” Two points were earned in part (b): 1 point for correctly identifying that a living green roof “provides a habitat for organisms” and 1 point for correctly identifying “more photosynthesizing plants” as an environmental benefit. The response earned 2 points in part (c). One point was earned for describing that “serving food that belongs on a lower trophic levels” will decrease the environmental impact of the high school, supported with the claim that “serving food on higher trophic levels — such as cattle — require more resources like water and crops in order to feed and sustain that cattle.” A second point was earned for correctly describing how the cafeteria serving “organic food that did not use fertilizers or pesticides in its production process ... would reduce the amount of persistent [*sic*] pesticides that accumulate in the environment.” No points were earned in part (d). The student identifies that native plants “provide a habitat for naturally occurring organisms in that area,” but does not discuss an increase in biodiversity or native food webs. The response earned 1 point in part (e) for discussing that “to create synthetic fibers for carpeting, chemicals/toxins are used. These toxins ... [are] released into the environment. Producing plant material flooring uses less of these chemicals in the process.”

### Sample: 1C

Score: 6

The response earned 3 points in part (a): 1 point in (a)(i) for correctly describing “the amount of carbon dioxide ... released by various human activities” as the definition of a carbon footprint; 1 point in (a)(ii) for correctly identifying that the “combustion of fossil fuels ... create[s] ... carbon dioxide”; and 1 point in (a)(iii) for describing that “[t]he school could use renewable alternative energy sources. ... This includes solar, wind, or hydroelectric energy ... as its main source of energy, [and] much less CO<sub>2</sub> would be released.” No points were earned in part (b). The response earned 2 points in part (c): 1 point for correctly describing that the “cafeteria could purchase foods that were locally grown ... less gasoline would be needed to be burned to transport the food” and 1 point for describing the practice of “buying foods from farms that did not use many pesticides.” This is an environmental benefit because “the pesticides ... may be toxic to organisms in the aquatic ecosystem.” No points were earned in part (d). The response does not discuss how native plants provide native habitat areas; thus, increase biodiversity. The response earned 1 point in part (e) for discussing that “bamboo and cork could easily be renewed by growing, meaning more flooring could be made ... carpet ... fibers are made from petroleum, which is non-renewable.”