

2023

AP[®]



AP[®] Environmental Science

Sample Student Responses and Scoring Commentary Set 1

Inside:

Free-Response Question 2

- Scoring Guidelines**
- Student Samples**
- Scoring Commentary**

Question 2: Analyze an Environmental Problem and Propose a Solution **10 points**

(a) Based on the information in the diagram, **identify** the temperature range of the water through which the majority of the adult manatee’s daily movement occurs. **1 point**

- 13–19°C

(b) Large groups of manatees are often observed in shallow waters near the waste water released by the electrical power plant during the winter. Based on the information in the diagram, **identify** a characteristic of the power plant waste water that would attract the manatees. **1 point**

Accept one of the following:

- The waste water/It is warm.
- The waste water/It is between 24–26°C.

(c) Based on the information in the diagram, **describe** a potential negative impact of the waste water released by the power plant on other aquatic species. **1 point**

Accept one of the following:

- Warming of the water near where the waste water/it is released reduces the amount of dissolved oxygen available for aquatic organisms to use/breathe.
- Warming of the water near where the waste water/it is released could impact the survival/health of species with a range of tolerance for the original/lower water temperatures.
- Warming of the water near where the waste water/it is released could alter/affect the timing of reproductive cycles for aquatic species.

(d) (i) **Describe** a characteristic of the manatees that increases their vulnerability to the recent decline of seagrasses. **1 point**

Accept one of the following:

- They eat seagrass/are herbivores, so they would have less food/starve.
- They require a lot of energy to survive, so they would have less food/starve.
- They inhabit warm water, so they would need to travel to colder waters/further to find food/seagrass.
- They have a low reproductive/maturation rate, so they would take longer to recover from loss of food source.

(d) (ii) **Describe** the change in energy flow through the trophic levels that occurs when there is a significant loss of seagrasses. **1 point**

Accept one of the following:

- Less energy will flow/is available to organisms in higher trophic levels.
- Less energy from the Sun is stored by producers.

Total for part (d) **2 points**

(e) (i)	Propose a solution to reduce nutrient or sediment pollution in an estuary that is surrounded by urban development.	1 point
	Accept one of the following: <ul style="list-style-type: none">• Replace existing pavement with permeable pavement.• Add vegetation where it will intercept runoff.• Reduce fertilizer use in the area.• Install barriers/Construct fences where they will intercept runoff.• Improve wastewater treatment plants in the area.	
(e) (ii)	Justify the solution proposed in part (e)(i) by providing an additional advantage of reduced nutrients in an estuary, other than one related to manatees.	1 point
	Accept one of the following: <ul style="list-style-type: none">• Reduces eutrophication.• Increases biodiversity/species richness.• Improves water clarity.• Increases ecotourism.• Reduces cost of water treatment.• Increases profits for commercial fisherman.	
	Total for part (e)	2 points
(f)	Describe how summertime weather conditions can increase the frequency of photochemical smog.	1 point
	Accept one of the following: <ul style="list-style-type: none">• Sunlight is more intense/there is more sunlight in summer, and more primary pollutants/nitrogen oxides/NO_x react in sunlight.• Summertime temperatures are warmer than other seasons, and chemical reactions occur more quickly in warmer temperatures.• Trees release more VOCs in summer leading to more reactions that form photochemical smog.	
(g)	Identify one ecological problem that results from exposure to photochemical smog.	1 point
	Accept one of the following: <ul style="list-style-type: none">• Causes respiratory problems/eye irritation in animals.• Reduces photosynthesis.• Slows/Inhibits/Stunts plant growth.• Increases the susceptibility of plants to pests and disease.	

(h) **Describe** a potential disadvantage of using hydrogen fuel cells to power automobiles. **1 point**

Accept one of the following:

- High cost to manufacture automobiles that use hydrogen fuel cells.
- Obtaining hydrogen requires a lot of energy/may consume more energy than the hydrogen fuel can produce.
- Hydrogen is explosive/flammable (may catch fire).
- Lack of infrastructure (such as fueling stations) for hydrogen fuel.
- Obtaining hydrogen often uses fossil fuels.
- Hydrogen must be obtained by separating it from natural gas or water.

Total for question 2 10 points

Important: Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3

Begin your response to each question at the top of a new page. Do not skip lines.

2a). The most common temperature range for the manatees would be between 13-19°C

2b). A characteristic of the waste water that attracts the manatees is the warmer temperature of the water, which is around 24-26°C

2c). Higher temperatures in water would decrease the amount of dissolved oxygen in the water. This can cause high levels of mortality among fish populations there.

2di). Since manatees mature slowly, they are at a higher risk for extinction because their populations would not be able to recover fast enough amidst the declining food availability.

2dii). Since seagrass is a producer, there would be a significant decrease in energy available in the entire food chain. Primary consumers will be left without a food source.

2ei). A solution to stop nutrient and sediment runoff would be to plant bushes and other fast growing plants around the edges of agricultural land upstream from the estuary.

2eii). An additional advantage of less available nutrients in an estuary is less eutrophication. Eutrophication can cause dead zones later on.

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Use a pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.

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Question 3



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2f). Hotter temperatures increase reaction rates between VOCs and Nox. This causes an increase in ozone levels in the troposphere

2g). Photochemical smog is a respiratory irritant that can cause lung problems in city-dwelling species, not just humans.

2h). Hydrogen fuel cells are significantly less energy efficient so refueling often would be a problem.

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Begin your response to each question at the top of a new page. Do not skip lines.

- A- The water ranges from 13°C to 26°C .
- B- The power plant release heat / thermal pollution which makes the surrounding water warmer and since manatees can't survive for long periods of time in water under 20°C , they would be attracted to the water near the power plant which ranges from $24 - 26^{\circ}\text{C}$.
- C- The warm water may negatively impact other animals who can not survive in water of that temperature and they may be forced to migrate or adapt to the new conditions.
- b-i- Manatees are K-selected specialists who can't eat a variety of plant life.
- b-ii- Lower amounts of sea grass means lower amounts of energy which can be passed on to primary consumers (like manatees), this also means less energy passed on to secondary consumers who eat primary consumers.
- E-i- The government can raise emissions standards for what power plants can release.
- e-ii- Reduced nutrients in ~~storing~~ estuaries means less risk of cultural eutrophication. There will be low risk of an algae bloom without excessive nutrient levels present.

Page 4

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f - In order for photochemical smog to form ~~VOx~~ and VOCs and NO_x need to combine with sunlight and heat, in the summer there is more sunlight and heat present.

g - smog blocks sunlight which leads to reduced photosynthesis and intern lower plant growth.

h - many people will already own older cars and may not want to switch to new hydrogen fuel cell powered cars so the majority of cars would still be running of gasoline combustion.

Page 5

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Question 1

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Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

a) 13-19°C is the temperature range of water through which the majority of the adult manatee's daily movement occurs.

b. The warm temperature of the power plant's waste water would attract the manatees.

c. The waste water released by the power plant contains harmful chemicals, which could cause disease-causing genetic mutations on aquatic species.

di. Manatees maintain their food source from seagrasses, which makes them vulnerable to the decline of seagrass beds.

dii. When there is a significant loss of seagrass, there will be a decrease in energy flow because if organisms towards the bottom of the food chain are losing their food source, they will have a higher mortality rate; causing their predators at the top of the food chain to have a harder time finding food as well.

ei. Planting trees can prevent nutrient and

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Question 1

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Begin your response to each question at the top of a new page. Do not skip lines.

sediment runoff,

eii. Reduced nutrients in an estuary can prevent the bioaccumulation of toxins.

f. summertime weather conditions can increase photochemical smog because there is more sunlight.

g. Photochemical smog can cause certain organisms to not be able to see as well in their environment.

h. Hydrogen fuel cells can lead to explosions if there is a car accident.

Use a pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.

Question 2

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

The intent of this question was for students to identify, describe, propose a solution to the problem of nutrient and sediment runoff causing seagrass decline, and justify a solution to the environmental problem. This question focused on the broad categories of aquatic and terrestrial pollution, atmospheric pollution, and ecosystem structure and energy resources. The content ranged from ecological concepts such as range of tolerance and energy transfer through trophic levels, to aquatic pollution concepts such as thermal, nutrient, and sediment pollution, to atmospheric pollution topics, including photochemical smog formation.

In parts (a), (b), and (c) students were asked to interpret a map of manatee habitat and identify the water temperature range in which manatee movement occurs, identify the characteristic of power plant water that attracts the manatees, and describe a potential negative impact of the waste water from the power plant on other aquatic species [Science Practice 2 Visual Representations, Topic 2.4 Ecological Tolerance, and Topic 8.6 Thermal Pollution].

In part (d) students were asked to describe a characteristic of manatees that increased their vulnerability to the decline of seagrasses in their habitat, and then describe the change in energy flow through the trophic levels because of this decline [Science Practice 1 Concept Explanation, Topic 1.9 Trophic Levels, and Topic 1.11 Food Chains and Food Webs].

In part (e) students proposed a solution to reduce nutrient and sediment pollution in an estuary that is surrounded by urban development, and then justified their solution by providing an additional advantage of reduced nutrients in an estuary (other than one related to manatees) [Science Practice 7 Environmental Solutions and Topic 8.4 Human Impacts on Wetlands and Mangroves].

In parts (f) and (g) students were asked to describe the effects of environmental factors on photochemical smog and to identify an environmental problem resulting from exposure to photochemical smog [Science Practice 7 Environmental Solutions, Topic 7.2 Photochemical Smog].

In part (h) students were asked to describe the effects of the use of hydrogen fuel cells in power generation on the environment [Science Practice 1 Concept Explanation, Topic 6.11 Hydrogen Fuel Cell].

Sample: 2A

Score: 9

One point was earned in part (a) for identifying “13–19°C” as the temperature range of the water. One point was earned in part (b) for identifying “warmer temperature” as a characteristic of the waste water that would attract manatees. One point was earned in part (c) for describing “would decrease the amount of dissolved oxygen in the water. This can cause high levels of mortality among fish populations” as a negative impact that the waste water would have on other aquatic species.

Question 2 (continued)

One point was earned in part (d)(i) for describing “Since manatees mature slowly ... their population would not be able to recover fast enough amidst the declining food availability” as a characteristic of the manatees that increases their vulnerability. One point was earned in part (d)(ii) for describing that “there would be a significant decrease in energy available in the entire food chain. Primary consumers would be left without a food source” as the change in energy flow when there is a loss of seagrasses. One point was earned in part (e)(i) for proposing “plant bushes and other fast growing plants around the edges ... upstream from the estuary” as a solution to reduce nutrient or sediment pollution in an estuary in an urban area. One point was earned in part (e)(ii) for justifying the solution in part (e)(i) by providing the additional advantage of “less eutrophication.” One point was earned in part (f) for describing “Hotter temperatures increase reaction rates between VOCs and NO_x.” One point was earned in part (g) for identifying “a respiratory irritant that can cause lung problems for city-dwelling species, not just humans” as an ecological problem that results from exposure to photochemical smog. No point was earned in part (h).

Sample: 2B**Score: 6**

No point was earned in part (a). One point was earned in part (b) for identifying “makes the surrounding water warmer” as a characteristic of the waste water that would attract manatees. One point was earned in part (c) for describing “animals who can not survive in water of that temperature and they may be forced to migrate” as a negative impact that the waste water would have on other aquatic species. No point was earned in part (d)(i). One point was earned in part (d)(ii) for describing “lower amounts of energy which can be passed on to primary consumers like manatees, this also means less energy is passed on to secondary consumers who eat primary consumers” as the change in energy flow when there is a loss of seagrasses. No point was earned in part (e)(i). One point was earned in part (e)(ii) for justifying the solution in part (e)(i) by providing the additional advantage of “less risk of cultural eutropication.” One point was earned in (f) for describing “VOCs and NO_x need to combine with sunlight and heat, in the summer there is more sunlight and heat present.” One point was earned in part (g) for identifying “reduced photosynthesis” as an ecological problem that results from exposure to photochemical smog. No point was earned in part (h).

Sample: 2C**Score: 4**

One point was earned in part (a) for identifying “13–19°C” as the temperature range of the water. One point was earned in part (b) for identifying “warm temperature” as a characteristic of the waste water that would attract manatees. No point was earned in part (c). No point was earned in part (d)(i). One point was earned in part (d)(ii) for describing “a decrease in energy flow ... causing ... predators at the top of the food chain to have a harder time finding food” as the change in energy flow when there is a loss of seagrasses. No point was earned in part (e)(i). No point was earned in part (e)(ii). No point was earned in part (f). No point was earned in part (g). One point was earned in part (h) for describing “Hydrogen fuel cells can lead to explosions if there is a car accident” as a disadvantage of using hydrogen fuel cells to power automobiles.