

2024



AP[®] Environmental Science

Sample Student Responses and Scoring Commentary Set 1

Inside:

Free-Response Question 1

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

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

(a) Based on the information in the diagram, **identify** the zone with the lowest level of dissolved oxygen. **1 point**

- Zone C/C

(b) Based on the information in the diagram, **describe** the relationship between biological oxygen demand and dissolved oxygen. **1 point**

Accept one of the following:

- As biological oxygen demand increases, dissolved oxygen decreases.
- As biological oxygen demand decreases, dissolved oxygen increases.
- As dissolved oxygen increases, biological oxygen demand decreases.
- As dissolved oxygen decreases, biological oxygen demand increases.

(c) Based on the information in the diagram, **identify** the zone where there is likely point-source water pollution discharged into the stream. **1 point**

- Zone B/B

(d) **Identify** the dependent variable in the researchers' investigation. **1 point**

Accept one of the following:

- The number of macroinvertebrate species
- Macroinvertebrate diversity
- Macroinvertebrate species richness

(e) **Identify** a testable hypothesis for the researchers' investigation. **1 point**

Accept one of the following:

- As dissolved oxygen levels increase, the number of macroinvertebrate species increases.
 - As dissolved oxygen levels decrease, the number of macroinvertebrate species increases.
 - There is a direct/inverse relationship between dissolved oxygen levels and the number of macroinvertebrate species.
 - There is no relationship between biological oxygen demand and macroinvertebrate biodiversity.
-

(f) **Describe** the reason the researchers selected zone A to serve as the control in the investigation. **1 point**

Accept one of the following:

- Zone A/A/It is upstream from the source of pollution/organic waste/discharge/change.
- Zone A/A/It would not be affected by the source of pollution/organic waste/discharge/change.
- Zone A/A/It has levels of dissolved oxygen that are not impacted by the source of pollution/organic waste/discharge/change.

(g) **Explain** how the modification to collect data in the winter months could alter the results of the investigation. **1 point**

Accept one of the following:

- Cold water will have more dissolved oxygen, which could increase the number of species.
- Colder water may be below the range of tolerance for some of the organisms, which could decrease the number of species.
- Lower light levels in the winter decrease plant activity/photosynthesis, which lowers dissolved oxygen levels, which could decrease the number of species.

(h) **Describe** the effect that the introduction of raw sewage into the stream could have on the population of bacteria in the stream. **1 point**

Accept one of the following:

- Raw sewage contains nutrients that could increase the population of bacteria.
- Raw sewage contains bacteria that could increase the population size.

(i) **Identify** an abiotic factor other than dissolved oxygen and organic pollution that could also influence the population size of bacteria in the stream. **1 point**

Accept one of the following:

- Temperature
 - pH
 - Light/Sunlight
 - Turbidity/Sediment
 - Salinity
 - Nitrate/Phosphate
-

- (j)** **Explain** how persistent organic pollutants can affect higher trophic levels in an aquatic food web. **1 point**

Accept one of the following:

- Persistent organic pollutants/Pollutants can bioaccumulate in the tissues of organisms at higher trophic levels because they consume prey that have accumulated the pollutants.
- Persistent organic pollutants/Pollutants can accumulate/concentrate in the tissues of organisms at higher trophic levels because they consume prey that have accumulated the pollutants.
- Persistent organic pollutants/Pollutants can bioaccumulate in organisms at higher trophic levels because of higher fat content in their tissues.
- Organisms at higher trophic levels can experience neurological toxicity because persistent organic pollutants bioaccumulate.

Total for question 1 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.

a) The zone is zone C.

b) As dissolved oxygen decreases, biological oxygen demand increases.

c) The zone is zone B.

d) The dependent variable is the number of macroinvertebrate species.

e) ~~As~~ If the level of dissolved oxygen decreases then there will be lesser, ^(smaller) number of macroinvertebrate species in the zones.

f) Zone A is the control because it is upstream of the point source meaning its dissolved oxygen levels are unaffected by the point source and it can therefore show ^{regular} ~~normal~~ levels of dissolved oxygen and macroinvertebrate species in the stream ecosystem.

g) The modification could change the results because ~~dur~~ during summer months the ~~water~~ water is hotter so it has less dissolved oxygen whereas during winter months the water is colder so it has ~~more~~ more dissolved oxygen.

Page 2

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 1

Question 2

Question 3



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

h) The introduction of raw sewage increases the population of bacteria in the stream, due to an increase in algae ^{due to an algae bloom} and broken down ^{by the bacteria}, which is ~~consumed~~ consumed by the bacteria.

i) ~~A~~ One abiotic factor is amount of sunlight available.

j) Persistent organic pollutants ^(POPs) negatively affect higher trophic levels because the POPs can biomagnify meaning it increases in concentration as it goes up the trophic levels due to higher trophic level animals eating numerous smaller trophic level animals that have bioaccumulated the POPs.

Page 3

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Question 1

Question 2

Question 3

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

- a. Zone C has the lowest level of dissolved oxygen.
- b. Dissolved oxygen and biological oxygen demand have an inverse relationship. When one is increased the other is decreased.
- c. Zone B is most likely when there is point-source water pollution.
- d. The independent variable in this experiment is the dissolved oxygen levels.
- e. An increase in dissolved oxygen levels will ~~also~~ lead to an increase in macroinvertebrate species.
- f. The researchers selected Zone A as the control because it is the zone before the point-source pollution is introduced.
- g. The cooler temps in winter months could alter the results of the investigation.
- h. The introduction of raw sewage decreases the amount of dissolved oxygen which is needed by the bacteria. ~~Without~~ Without the oxygen the bacteria can not break down organic matter and the population will decrease.
- i. Another abiotic factor that could influence the population size is the increase in sediments.
- j. Persistent organic pollutants can decrease or even wipe-out populations on the lower trophic levels. Without the populations of the lower trophic levels, the higher trophic level populations will also decrease in population.

Page 2

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Question 1

Question 2

Question 3

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

A → zone C has the lowest level of dissolved oxygen

B → the relationship between biological oxygen demand & dissolved oxygen is an inverse relationship, shown when dissolved oxygen is higher, biological oxygen demand is lower

C → zone B is most likely point source water pollution discharged into stream

D → the dependent variable in this investigation is the amount of water & the species naturally in the zones

E → zone E has more species richness due to the high amounts of dissolved oxygen

F → Researchers selected zone A as the control group because there was one of each species & the dissolved oxygen & biological oxygen demand were constant & stable throughout the zone & equal

G → repeating ~~the~~ their data in the winter months could alter the results of the investigation because some animals ~~can't~~ don't breed in the winter, ~~therefore~~ therefore affecting numbers & maybe the biological oxygen demand raised higher in winter because of the cold.

H → the introduction of raw sewage into the stream could affect the population of bacteria in the stream by changing the pH & affecting oxygen levels which would affect the aquatic species life

I) an ^{abiotic} ~~abiotic~~ factor that could also influence the population size of bacteria in the stream is bringing in a new

Page 2

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Question 1

Question 2

Question 3



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

1 → species from another ecosystem, which could possibly have diseases

2 → persistent organic pollutants can affect higher trophic levels in an aquatic food web by entering the higher species, whether with bacteria, diseases could affect the entire trophic ^{level} ~~levels~~ because of ~~the~~ one species.

Page 3

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Question 1

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

Overview

The intent of this question was for students to demonstrate their ability to interpret an oxygen sag curve diagram. Students were asked to describe the effects of point-source pollution on dissolved oxygen levels and macroinvertebrate species biodiversity in a stream. Students were also asked to explain how persistent organic pollutants are passed through a food web in an ecosystem. The question included elements of experimental design, where students were asked to state a hypothesis, describe a reason for using an experimental control, and identify the dependent variable from an experiment.

In parts (a–c) students were asked to use information from the oxygen sag curve diagram to identify the area with the lowest levels of dissolved oxygen, describe the relationship between biological oxygen demand and dissolved oxygen, and identify where there is likely point-source water pollution discharged into the stream [Science Practice 2 Visual Representations and Topics 8.1 Sources of Pollution and 8.2 Human Impacts on Ecosystems].

In parts (d–f) students were asked to read a brief passage about a scientific investigation into the relationship between dissolved oxygen levels and macroinvertebrate species richness in the stream. Students were then asked to identify the dependent variable for the researchers' investigation, identify a testable hypothesis for the researchers' investigation, and describe the reason the researchers selected zone A to serve as the control in the investigation [Science Practice 4 Scientific Experiments].

In part (g) students were asked to explain how the modification to collect data in the winter months could affect the results of the investigation [Science Practice 4 Scientific Experiments and Topic 2.4 Ecological Tolerance].

In part (h) students were asked to describe the effect that the introduction of raw sewage into the stream could have on the population of bacteria in the stream [Science Practice 7 Environmental Solutions].

In part (i) students were asked to identify an abiotic factor other than dissolved oxygen and organic pollution that could also influence the population size of bacteria in the stream [Science Practice 1 Concept Explanation and Topic 3.5 Population Growth and Resource Availability].

In part (j) students were asked to explain how persistent organic pollutants can affect higher trophic levels in aquatic food webs [Science Practice 1 Concept Explanation and Topics 8.7 Persistent Organic Pollutants and 8.8 Bioaccumulation and Biomagnification].

Sample: 1A

Score: 8

1 point was earned in part (a) for identifying “Zone C.” 1 point was earned in part (b) for describing “As dissolved oxygen decreases, biological oxygen demand increases.” 1 point was earned in part (c) for identifying “Zone B.” 1 point was earned in part (d) for identifying “the number of macroinvertebrate species.” 1 point was earned in part (e) for identifying “If the level of dissolved

Question 1 (continued)

oxygen decreases then there will be lesser (smaller) number of macroinvertebrate species.” 1 point was earned in part (f) for describing “because it is upstream of the point source.” No point was earned in part (g). No point was earned in part (h). 1 point was earned in part (i) for identifying “sunlight.” 1 point was earned in part (j) for explaining “POPs can biomagnify meaning it increases in concentration as it goes up trophic levels due to higher trophic level animals eating numerous smaller trophic level animals that have bioaccumulated the POPs.”

Sample: 1B

Score: 6

1 point was earned in part (a) for identifying “Zone C.” 1 point was earned in part (b) for describing “when one is increased the other is decreased.” 1 point was earned in part (c) for identifying “Zone B.” No point was earned in part (d). 1 point was earned in part (e) for identifying “An increase in dissolved oxygen levels will lead to an increase in macroinvertebrate species.” 1 point was earned in part (f) for describing “because it is the zone before the point-source pollution is introduced.” No point was earned in part (g). No point was earned in part (h). 1 point was earned in part (i) for identifying “sediment.” No point was earned in part (j).

Sample: 1C

Score: 3

1 point was earned in part (a) for identifying “Zone C.” 1 point was earned in part (b) for describing “when dissolved oxygen is higher, biological oxygen demand is lower.” 1 point was earned in part (c) for identifying “Zone B.” No point was earned in part (d). No point was earned in part (e). No point was earned in part (f). No point was earned in part (g). No point was earned in part (h). No point was earned in part (i). No point was earned in part (j).