ENVIRONMENTAL SCIENCE

SECTION II

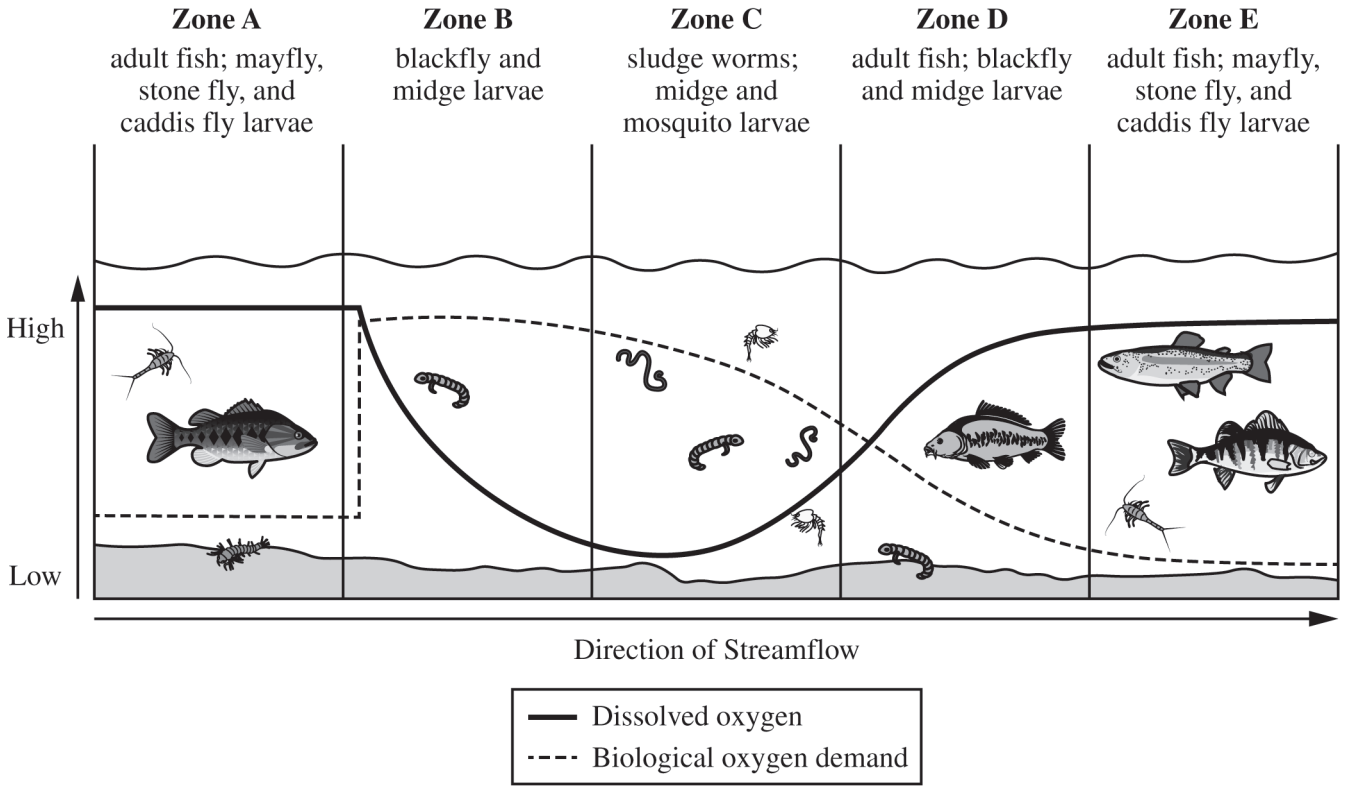
Time—1 hour and 10 minutes

3 Questions

Directions: Answer all three questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers in the Free Response booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples. You may plan your answers in this orange booklet, but no credit will be given for anything written in this booklet. **You will only earn credit for what you write in the separate Free Response booklet.**

1. Researchers are studying the stream ecosystem shown in the following diagram. They have identified five different zones based on the dissolved oxygen levels and biological oxygen demand as the water flows downstream. Biological oxygen demand is the amount of oxygen needed by bacteria and other microorganisms to break down organic material in water. Some of the most common fish and macroinvertebrate species found in each zone are listed in the diagram.

Dissolved Oxygen and Biological Oxygen Demand in a Stream Ecosystem



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

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

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

The research team is interested in investigating the relationship between dissolved oxygen levels and macroinvertebrate species richness in the stream. Researchers counted the number of macroinvertebrate species in zones A, B, and C during the summer months. The researchers selected zone A to serve as the control in the investigation.

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

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

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

The researchers decided to repeat their data collection during the winter months.

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

Stream ecosystems are affected by point-source organic pollution in a variety of ways.

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

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

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

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

GO ON TO THE NEXT PAGE.

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

(f)	**Describe** how water quality can be altered by cattle grazing that occurs near a stream or river. Accept one of the following: • Cattle cause erosion, which increases sedimentation/turbidity in water. • Cattle feces can add nutrients/nitrogen/phosphorus to waterways. • Cattle feces may contaminate waterways with bacteria.	**1 point**
(g)	**Propose** a solution to reduce the negative impacts on waterways that result from cattle grazing, while still allowing cattle to graze. Accept one of the following: • Practice rotational grazing/alternate grazing parcels. • Eat a diet with less meat/beef. • Fence/barricade the riparian zone. • Provide other water sources for the cattle.	**1 point**
(h)	Crop production can cause soil erosion. **Describe** a sustainable agricultural practice used to reduce soil erosion. Accept one of the following: • Switch crops to perennial plants. • Plant crops on terraces. • Implement contour plowing/farming. • Use no-till farming/cover crops.	**1 point**