

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

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:

- 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:

- 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:

- 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:

- 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