

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	

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- (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.
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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