

2017 AP[®] ENVIRONMENTAL SCIENCE FREE-RESPONSE QUESTIONS

ENVIRONMENTAL SCIENCE

SECTION II

Time—90 minutes

4 Questions

Directions: Answer all four questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers on the pages following the questions in this book. 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.

1. Read the following article from the *Fremont Daily Times* and answer the questions that follow.

Fremont Daily Times

Scientists Discuss Threats from Plastic Pollution

In testimony before the United States Senate Committee on Environment and Public Works, Dr. Duke Ewoldsen, an eminent toxicologist, discussed a new water pollutant that threatens aquatic life: microbeads. Ewoldsen noted that while posing a different threat than more conventional water pollutants such as nitrates, phosphates and PCBs, tiny beads of plastic contained in many products, especially cosmetics, now threaten plankton and small fish that ingest the particles because they mistake

them for food. The microbeads cannot be digested and can fill or block the digestive tracts of the fish, leading to starvation. In addition, surfaces of these small spheres can adsorb organic pollutants such as PCBs and dioxin.

When asked about steps to reduce this threat, Ewoldsen noted that the beads are so small that they are not easily removed by wastewater treatment plants and thus often enter aquatic ecosystems in wastewater discharges.

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Question 1

Read the following article from the *Fremont Daily Times* and answer the questions that follow.

- (a) **Describe** TWO effects that ingesting microbeads has on aquatic organisms.

(2 points: 1 point for each correct description of an effect of microbeads on aquatic organisms.)

- Microbeads fill or block the digestive tract
- Organisms accumulate toxic chemicals (PCBs, dioxins) from microbeads, leading to long-term health effects

- (b) Dr. Ewoldsen states that nitrates pose different threats to aquatic ecosystems than microbeads do. **Describe** how nitrate levels can negatively affect water quality in some aquatic ecosystems.

(2 points: 1 point for a correct description of the ecosystem response to increased nitrate levels and 1 point for a correct description of the effect of increased algal growth on water quality. The effect on water quality must be linked to response to increased nitrate levels to earn point.)

Response to increased nitrate levels	Effect on water quality
<ul style="list-style-type: none"> • Cause excessive algal growth or algal blooms • Cause cultural eutrophication • Speed eutrophication process 	<ul style="list-style-type: none"> • Algae die and microbes deplete the water of available oxygen (DO) during decomposition of algae (hypoxic/anoxic conditions) • Algal blooms increase turbidity • Algal blooms lead to reduced light penetration • Algal blooms cause taste/odor problems

- (c) While wastewater treatment plants are ineffective at removing microbeads, they are very effective at removing large pieces of plastic waste and other pollutants.

- (i) **Identify** one way large pieces of plastic are removed from wastewater during primary treatment.

(1 point for a correct identification of one way plastics are removed during primary treatment.)

Physical mechanism for removing plastics from the liquid component of wastewater, such as

- | | |
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| <ul style="list-style-type: none"> • Screens/Sieves • Settling • Nets | <ul style="list-style-type: none"> • Skimmers • Filters • Manual removal |
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- (ii) Prior to discharge, wastewater is often disinfected. **Identify** one technique commonly used to disinfect wastewater.

(1 point for a correct identification of one technique used to disinfect wastewater.)

- | | |
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| <ul style="list-style-type: none"> • Chlorination • Treatment with ultraviolet (UV) light | <ul style="list-style-type: none"> • Ozonation • Membrane filtration (reverse osmosis and ultrafiltration) |
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Question 1 (continued)

- (iii) Sludge or biosolids produced during the wastewater treatment process can be spread on agricultural fields. **Identify** one advantage and one disadvantage of this practice.

(2 points: 1 point for a correct identification of an advantage of spreading sludge and 1 point for a correct identification of a disadvantage of spreading sludge.)

Advantage	Disadvantage
<ul style="list-style-type: none"> • Used as fertilizer • Increases crop yields/crop revenue • Improves soil quality • Reduces need for disposal of sludge/biosolids in landfills or by incineration • Generates revenue from sale of sludge/biosolids • May be less expensive than commercial fertilizer • May be least expensive disposal option 	<ul style="list-style-type: none"> • Foul odors • Surface water and groundwater contamination by nutrients, heavy metals, pharmaceuticals, hormones, pathogens • Soil contamination by heavy metals, pharmaceuticals, hormones, pathogens • Crop contamination by heavy metals, pharmaceuticals, pathogens • Lack of public acceptance

- (d) Coastal ecosystems are threatened by other human activities in addition to wastewater disposal. Mangrove swamps are one such threatened ecosystem.

- (i) **Provide** one reason why mangrove trees are being removed by humans.

(1 point for a correct reason for why mangrove trees are being removed by humans.)

- Establishing aquaculture facilities (fish and shrimp farming)
- Expanding agriculture
- Developing coastal areas (e.g., marinas, condos, resorts, infrastructure)
- Harvesting mangroves for wood products, including paper pulp
- Burning mangroves for energy/charcoal production
- Removing mangroves for aesthetic reasons (to improve views)
- Removing trees to increase access to coastal waters

- (ii) **Identify** one ecosystem service provided by intact mangrove ecosystems.

(1 point for a correct identification of an ecosystem service provided by intact mangroves.)

- Shoreline stabilization/protection (e.g., storm surge, tsunami, wave action)
- Commercial fisheries
- Nursery grounds for aquatic organisms
- Biodiversity preservation
- Flood control
- Groundwater recharge
- Sediment/nutrient retention
- Nutrient cycling
- Absorption of carbon dioxide and release of oxygen
- Purification of water, air
- Ecotourism/tourism/recreational opportunities
- Protection from saltwater intrusion