

## **2010 AP® ENVIRONMENTAL SCIENCE FREE-RESPONSE QUESTIONS**

4. Scientific evidence shows a direct relationship between sea level and the global mean atmospheric temperature at Earth's surface. Increases in the global mean atmospheric temperature during the past century have been accompanied by a gradual increase in sea level; currently the average rate of increase in sea level is 3.0 mm/yr. Additional increases in sea level are expected during the next century as global mean atmospheric temperatures continue to rise. These increases in sea level will affect coastal ecosystems as well as human activity along coastal margins.
- (a) Based on the rate cited above, calculate the expected increase in sea level, in meters, during the next 50 years.
- (b) Identify TWO phenomena that result from an increase in global mean atmospheric temperature and that contribute to increases in sea level. For each phenomenon that you identify, explain how it causes sea level to increase.
- (c) Describe TWO environmental impacts that increasing sea level will have on an estuarine ecosystem such as those in the Mississippi Delta, Chesapeake Bay, and San Francisco Bay.
- (d) Although sea level has been rising for over a century, human populations in coastal areas have increased dramatically during this period.
- (i) Describe one negative economic impact that an increase in sea level will have on people who live along a coastline.
- (ii) Describe TWO viable strategies that governments could use to discourage people from moving to coastal areas.

**STOP**

**END OF EXAM**

**AP® ENVIRONMENTAL SCIENCE  
2010 SCORING GUIDELINES**

**Question 4**

- (a) Based on the rate cited above, calculate the expected increase in sea level, in meters, during the next 50 years.**

One point can be earned for the correct setup, and 1 point can be earned for the correct answer.

$$\frac{3.0 \text{ mm}}{\text{yr}} \times 50 \text{ yrs} = 150 \text{ mm} = 0.15 \text{ m}$$

OR

$$\frac{3.0 \text{ mm}}{\text{yr}} \times 50 \text{ yrs} \times \frac{1 \text{ m}}{1,000 \text{ mm}} = 0.15 \text{ m}$$

- (b) Identify TWO phenomena that result from an increase in global mean atmospheric temperature and that contribute to increases in sea level. For each phenomenon that you identify, explain how it causes sea level to increase.**

One point can be earned for each identification, and 1 point can be earned for each explanation. Only the first two answers will be considered.

<b>Phenomenon</b>	<b>Explanation</b>
Melting of glaciers, continental ice caps ( <i>“Ice caps” or “polar ice caps” are NOT acceptable answers by themselves.</i> )	As ice melts, the amount of water in the ocean increases.
Melting of ice sheets (Greenland and Antarctica)	As ice melts, the amount of water in the ocean increases.
Thermal expansion of the ocean	As water warms, water molecules move farther apart and the volume of the ocean increases.
Melting of Antarctic ice shelves	Ice shelves are attached to continental ice and do not displace liquid water; if they break off, they will displace water and raise sea level.

**AP® ENVIRONMENTAL SCIENCE  
2010 SCORING GUIDELINES**

**Question 4 (continued)**

- (c) Describe TWO environmental impacts that increasing sea level will have on an estuarine ecosystem such as those in the Mississippi Delta, Chesapeake Bay, and San Francisco Bay.**

One point can be earned for each description of an environmental impact. Only the first two impacts are considered.

<b>Impact</b>	<b>Description</b>
Loss/flooding/erosion of estuary habitat (conversion to open water)	<ul style="list-style-type: none"><li>• Loss of wetlands, marshes, salt marshes, intertidal zone, riparian zone, mangroves.</li><li>• May lead to changes in water depth, light levels and temperature, causing migration or local extinction of species that have specific requirements.</li><li>• Inland migration of wetlands.</li><li>• May lead to loss of species (fish, shellfish, birds) that rely on estuary as a nursery/breeding area.*</li><li>• May lead to loss of species that rely on estuary for protection from predators.</li><li>• May lead to loss of migratory species (birds) that rely on estuary as a stopover.</li></ul>
Increased nutrient loads in the water	Estuaries filter out excess nutrients; without them, eutrophication may lead to algal blooms.
Increased storm destruction of areas adjacent to the estuary	<ul style="list-style-type: none"><li>• Estuaries absorb excess water, reducing flooding.</li><li>• Estuaries provide a physical barrier that protects the area from storm surges, preventing erosion.</li><li>• Increased erosion of coastline leads to habitat loss.</li></ul>
Change in salinity	<ul style="list-style-type: none"><li>• Salinity may increase.</li><li>• May lead to loss of species that have a small salinity-tolerance range.</li></ul>
Waterlogged soils due to flooding	Loss of marsh plant species.

\*Student response should show understanding of estuarine ecosystem.

**AP® ENVIRONMENTAL SCIENCE  
2010 SCORING GUIDELINES**

**Question 4 (continued)**

<b>Impact</b>	<b>Description</b>
Spreading of oil spills that occur in ocean to inland areas	<ul style="list-style-type: none"><li>Oil may coat birds' feathers, reducing insulation and ability to fly.</li><li>Oil may coat mammals' coats; animals may ingest the oil during cleaning and die.</li><li>Oil may cause suffocation (organisms unable to perform gas exchange).</li></ul>

(d) **Although sea level has been rising for over a century, human populations in coastal areas have increased dramatically during this period.**

(i) **Describe one negative economic impact that an increase in sea level will have on people who live along a coastline.**

One point can be earned: only the first negative economic impact stated will be considered.

<b>Impact</b>	<b>Description</b>
Damage to private property	<ul style="list-style-type: none"><li>Cost of replacement, relocation, or improved construction to reduce storm damage.</li><li>Increased insurance premiums.</li><li>Decrease in property values (unable to sell).</li></ul>
Loss of income/livelihood	<ul style="list-style-type: none"><li>Loss of commercial fishing.</li><li>Loss of income-producing agricultural lands.</li><li>Loss of tourism dollars.</li></ul>
Loss of food supply	People who rely on fishing or agriculture in coastal areas will need to buy food.
Saltwater intrusion	Water supplies for drinking and irrigation may require expensive desalination treatment.

## **AP<sup>®</sup> ENVIRONMENTAL SCIENCE 2010 SCORING GUIDELINES**

### **Question 4 (continued)**

- (ii) Describe TWO viable strategies that governments could use to discourage people from moving to coastal areas.**

One point can be earned for each description; only the first two strategies will be considered.

- Raise premiums or refuse to insure in areas that repeatedly flood/are damaged by storms
- Raise property taxes in coastal areas
- Education campaigns, PSAs, advertising that discourage movement to the coast or encourage movement away from the coast
- Offer incentives to relocate inland, such as jobs, schools, reduced property taxes
- Designate the area as a preserve/reserve making it illegal to build
- Impose stricter penalties for infringements of regulations designed to protect the coastline
- Zone to restrict building in coastal areas, limit distance to coast
- Designate the beach as public property
- Remove or ban human structures designed to stabilize shoreline (seawalls, bulkheads)
- Ban the practice of beach nourishment
- Pass rolling easements in which property owners agree to abandon buildings when their properties become flooded
- Impose a tax to support beach-area protection
- Prevent the building of infrastructure/services (roads, power lines, water lines) that service coastal areas