



## **AP<sup>®</sup> Environmental Science 2013 Scoring Guidelines**

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**Question 1**

**(a) Identify TWO human activities that alter the natural flow of sediments into Gulf Coast ecosystems. Explain how each of the activities alters the flow of sediments.**

*(4 points: 1 point for each activity; 1 point for each explanation [change in sediment load must be linked to its appropriate activity]; only the first two answers are accepted)*

<b>Activity</b>	<b>Explanation</b>
Building dams*	<ul style="list-style-type: none"> <li>• Blocks flow of sediment from upstream, decreases deposition downstream (coast starved of sediments)</li> <li>• Prevents flooding that deposits sediment in floodplain</li> <li>• Increases flow velocity, increases downstream erosion</li> </ul>
Channelization/straightening/re-routing of river	<ul style="list-style-type: none"> <li>• Prevents deposition in wetlands</li> <li>• Increases velocity, decreases deposition in floodplain/coast starved if sediments carried offshore</li> </ul>
Building levees*	<ul style="list-style-type: none"> <li>• Prevents deposition in wetlands</li> <li>• Increases velocity, sediments carried offshore</li> </ul>
Loss of riparian/buffer zones and degraded stream banks*	<ul style="list-style-type: none"> <li>• Increases erosion, increases sediment load to river</li> <li>• Decreases sediment trapping due to root loss, increases sediment load to river</li> </ul>
Agriculture/irrigation practices	<ul style="list-style-type: none"> <li>• Increases erosion, increases sediment load to river</li> </ul>
Construction/urbanization	<ul style="list-style-type: none"> <li>• Increases erosion, increases sediment load to river</li> <li>• Decreases infiltration leading to greater runoff, increases sediment load to river</li> </ul>
Deforestation/logging*	<ul style="list-style-type: none"> <li>• Increases erosion, increases sediment load to river</li> <li>• Decreases sediment trapping because of root loss, increases sediment load to river</li> </ul>
Water use/extraction	<ul style="list-style-type: none"> <li>• Over pumping/use of water reduces river flows, decreases sediment load to Gulf</li> </ul>
Dredging/ditching*	<ul style="list-style-type: none"> <li>• Removes sediment from the ecosystem</li> <li>• Increases erosion, increases sediment load to river</li> </ul>
Draining of wetlands*	<ul style="list-style-type: none"> <li>• Increases erosion due to increased overland flow, increases sediment load to river</li> <li>• Decreases sediment trapping because of vegetation loss, increases sediment load to river</li> </ul>
Overgrazed rangelands*	<ul style="list-style-type: none"> <li>• Increases erosion, increases sediment load to river</li> </ul>
Mining (strip mining)*	<ul style="list-style-type: none"> <li>• Increases erosion, increases sediment load to river</li> </ul>

\*opposite activities and explanations accepted as appropriate

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**Question 1 (continued)**

**(b) Dr. James says that it is important to restore sediments. Describe TWO ways that the loss of natural sediment harms Gulf Coast wetland ecosystems.**

*(2 points: 1 point for each description [must be ecological, not economic]; only the first two descriptions provided can earn points)*

- Conversion of wetlands to open water (flooding) due to lack of sediment renewal
- Loss of nutrients that are needed to maintain wetland plants (lower productivity)
- Loss of plant productivity leads to loss of biomass at higher trophic levels
- Loss of replenishment for floodplain soils, coastal beaches, barrier islands, marshes, estuaries
- Loss of specific coastal habitats (e.g., bird breeding areas, fish nurseries)
- Flooding of coastal wetlands due to loss of barrier islands and beaches

**(c) Dr. James also indicates that it is necessary to limit fertilizer runoff into the Gulf of Mexico.**

**(i) Describe TWO environmental impacts on the marine ecosystem that are caused by fertilizer as it flows into the Gulf of Mexico.**

*(2 points: 1 for each impact description [must be ecological, not economic]; only the first two descriptions provided can earn points)*

- Over-enrichment by excess nutrients (nitrates and phosphates)
- Increased growth of algae
- Decreased levels of light/decreased levels of photosynthesis
- Formation of dead zone (increased fish/shellfish death)
- Lower dissolved oxygen (hypoxic/anoxic conditions)
- Increased populations of bacteria
- Increased biochemical oxygen demand (BOD)/increased respiration of decomposers
- Outbreaks of red tides/harmful algal blooms (HABs)

**(ii) What are TWO economic consequences that are caused by fertilizer when it flows into the Gulf of Mexico?**

*(2 points: 1 for each consequence [must be economic, not ecological]; only the first two consequences provided can earn points)*

- Decreased income/revenue due to lower fish catches (e.g., shrimp, oysters, fin fish)
- Loss of jobs in the fishing industry
- Lower rates of tourism due to impacts (e.g., HAB, lower fish diversity, less aesthetically pleasing)
- Cost of cleanup of fish kills
- Increased seafood prices due to lower seafood supply
- Lower sales of seafood due to HABs
- Loss of property taxes if people move away
- Decreased property values

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**Question 1 (continued)**

**(iii) Describe ONE strategy, other than reducing the use of fertilizer, that can be employed to reduce the flow of nutrients into the Mississippi River.**

*(1 point for a description of a reduction strategy; only the first description provided can earn points)*

- Protection, re-establishment of riparian/buffer zones (replanting) to trap fertilizer
- Limit farming near floodplains
- Limit development (e.g., lawns, golf courses) near floodplains
- Improve agricultural or residential practices (use techniques such as intercropping, cover crops, no till, timing of fertilizer application)
- Treatment of storm water to reduce nutrients before releasing into river
- Requirement of tertiary treatment for wastewater treatment plants and other point sources
- Education of public on techniques to reduce nutrient flow
- Limit septic systems near riparian zones
- Treatment of waste from livestock farms (CAFOs) to reduce nutrients
- Catchment basins/retention ponds to trap nutrients
- Green roofs to decrease runoff
- Permeable pavement to reduce flow of water into waterways

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**Question 2**

**(a) Identify THREE strategies that the federal government could implement to encourage the use of battery electric vehicles (BEVs).**

*(3 points: 1 point for each strategy; examples of acceptable strategies are shown)*

The federal government could:

- Increase subsidies for BEV industry **OR** decrease subsidies for ICE industry
- Increase tax on carbon/gasoline/diesel fuel
- Offer tax incentives or rebates for purchasing BEVs **OR** institute a tax on the purchase of ICE vehicles
- Increase subsidies for power companies **OR** decrease subsidies for petroleum industry
- Run educational campaigns/commercials/PSAs supporting BEVs
- Allow BEVs to use HOV/carpool lanes or provide funds for BEV lanes
- Replace federal ICE vehicles with BEVs
- Restrict ICE vehicles (e.g., prohibit use of ICE vehicles in urban areas or at certain times)
- Make charging stations more accessible
- Adopt stricter federal standards for tailpipe emissions or gas mileage (e.g., CAFE)
- Offer tax incentives for purchasing home charging stations
- Offer financial incentives for trading in an ICE vehicle for a BEV

**(b) Assume that the fuel efficiency of the ICE vehicle is 25 miles per gallon (mpg) and that gasoline costs \$3.75 per gallon (gal). Calculate the cost of gasoline per mile.**

*(2 points: 1 point for the correct setup (including units) and 1 point for the correct answer)*

$$\frac{\$3.75}{\text{gal}} \times \frac{\text{gal}}{25 \text{ miles}} = \$0.15 \text{ [per mile]} \quad \text{OR} \quad \frac{\$3.75}{25 \text{ miles}} = \$0.15 \text{ [per mile]}$$

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**Question 2 (continued)**

**(c) The charger supplies energy to the BEV battery at an average rate of 4.0 kilowatts (kW) and fully charges the BEV battery in 7.0 hours. The car will run for 100 miles on a full charge. The cost of electricity is \$0.11 per kilowatt-hour (kWh).**

**(i) Calculate the cost of the electricity to fully charge the battery. Assume that the battery is not charged to begin with.**

*(2 points: 1 point for the correct setup (including units) and 1 point for the correct answer)*

$$7.0 \text{ hours} \times 4.0 \text{ kW} \times \frac{\$0.11}{\text{kWh}} = \$3.08^*$$

*\*\$3.10 also earns a point.*

**(ii) Calculate the cost of electricity per mile to drive the BEV.**

*(1 point can be earned for the correct answer, with or without work shown; wrong answer from (c)(i), used correctly, can still earn a point)*

$$\frac{\$3.08}{100 \text{ miles}} = \$0.03 \text{ [per mile]}$$

**(d) Calculate the difference in the amount of CO<sub>2</sub> that would enter the atmosphere if both cars were driven 100 miles.**

*(1 point can be earned for the correct answer with work shown; first equation is optional)*

$$\begin{aligned} 72.8 + 17.7 &= 90.5 \text{ lb} \\ 90.5 - 63.6 &= 26.9 \text{ lb} \end{aligned}$$

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**Question 2 (continued)**

**(e) Describe TWO economic impacts (excluding costs related to climate change resulting from CO<sub>2</sub> emissions or the cost of gasoline at the pump) that result from an increased number of BEVs on the road.**

*(2 points: 1 point for each correct impact; only 1 point is allowed per row in table)*

<b>Impacts from Increased Use of BEVs Include:</b>	<b>Impacts from Decreased Use of ICE Vehicles Include:</b>
Increase in jobs/profit in electrical industry (e.g., power plants, charging stations)	Decrease in jobs/profit in gasoline/petroleum industry (e.g., gas stations)
Increase in expenditures for production of electricity (e.g., exploration, coal mining, building wind farms) or for transport of coal/transmission of electricity	Decrease in expenditures for the production or transport of petroleum (e.g., exploration, drilling, refining)
<b>OR</b>	<b>OR</b>
Increase in revenue in industries related to the production of electricity (e.g., coal mines, wind turbine producers)	Decrease in revenue in industries related to the production or transport of petroleum (e.g., exploration, drilling, refining)
Increase in jobs/profit for manufacturing and repair of BEVs	Decrease in jobs/profit for manufacturing and repair of ICE vehicles
Increase or decrease in cost of BEVs with appropriate supporting explanation (e.g., economies of scale, law of supply and demand)	Increase or decrease in cost of ICE vehicles with appropriate supporting explanation (e.g., economies of scale, law of supply and demand)
Increase in expenditures associated with controlling smokestack emissions (e.g., SO <sub>2</sub> ) from power stations	Decrease in expenditures for cleanup of oil spills or gasoline leaks
Increase in price of electricity or fuel used to generate electricity because of increased demand	Decrease in revenue from gas tax
<b>OR</b>	
Increase in household expenditures for electricity	
BEV drivers save money that can be spent elsewhere	
Expenses required for installing charging stations or converting gas stations	
Decrease in expenditures for health care associated with exposure to air pollution (e.g., photochemical smog, gasoline vapors)	
Increase in expenses for/sales of batteries or for battery disposal	

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**Question 3**

- (a) Identify the type of solar radiation that is absorbed by stratospheric ozone and describe one human health benefit that results from the absorption of this solar energy.**

*(2 points: 1 point for identifying ultraviolet (UV, UV-B, or UV-C) radiation as the type absorbed by stratospheric ozone and 1 point for a correct description of a health benefit resulting from the absorption of UV radiation in the stratosphere; only the first type of solar radiation and health effect can earn points)*

The following are acceptable human health benefits resulting from the absorption of UV radiation in the stratosphere:

- Low rates of skin cancer (e.g., basal cell carcinoma, squamous cell carcinoma, melanoma)
- Low rates of sunburns
- Low rates of eye damage (e.g., cataracts)

- (b) The absorption of solar energy by stratospheric ozone causes ozone molecules to undergo chemical decomposition and formation. Describe the chemical processes that lead to this natural balance between decomposition and formation of stratospheric ozone (you may use chemical equations in your answer).**

*(2 points: 1 point for a correct description of the chemical decomposition of stratospheric ozone and 1 point for a correct description of the formation of stratospheric ozone)*

Correct descriptions of the chemical decomposition of stratospheric ozone include one of the following:

- Ozone absorbs UV radiation, producing an oxygen molecule and an oxygen atom
- Ozone molecules absorb UV radiation, producing oxygen molecules
- $O_3 + UV \rightarrow O_2 + O$
- $2O_3 + UV \rightarrow 3O_2$

Correct descriptions of the chemical formation of stratospheric ozone include one of the following:

- An oxygen molecule reacts with an oxygen atom to form ozone
- Oxygen molecules absorb UV radiation, forming ozone molecules
- $O_2 + O \rightarrow O_3$
- $3O_2 + UV \rightarrow 2O_3$

**OR:**

The chemical decomposition and formation of stratospheric ozone may be described together:

- Ozone absorbs UV radiation producing an oxygen molecule and an oxygen atom, which then react to form ozone
- $O_3 + UV \rightarrow O_2 + O \rightarrow O_3$

(Note: This combined explanation earns both points.)



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**Question 3 (continued)**

**(c) The Montreal Protocol of 1987 provided a global framework to phase out chlorofluorocarbon (CFC) production and use. Although the Montreal Protocol has led to a dramatic decrease in CFCs released into the atmosphere, stratospheric ozone destruction has decreased only slightly.**

**(i) Explain the process by which CFCs lead to the destruction of stratospheric ozone. (You may use chemical equations in your answer.)**

*(2 points: 1 point for a correct description of the decomposition of CFCs and 1 point for a correct description of the reaction of ozone with chlorine)*

Correct descriptions of the decomposition of CFCs include one of the following:

- Absorption of UV radiation by CFC molecules releases chlorine atoms
- $\text{CCl}_3\text{F} + \text{UV} \rightarrow \text{CCl}_2\text{F} + \text{Cl}$

Correct descriptions of the destruction of stratospheric ozone include one of the following:

- Chlorine atoms break down ozone molecules
- $\text{Cl} + \text{O}_3 \rightarrow \text{ClO} + \text{O}_2$

**(ii) Explain why the rapid decrease in CFC emissions has not led to a similarly rapid decrease in the destruction of stratospheric ozone.**

*(1 point can be earned for a correct explanation linking the absence of a rapid decrease in the destruction of stratospheric ozone with one of the following):*

- The slow migration of CFCs into the stratosphere.
- The long lifetime of CFCs and/or chlorine in the stratosphere.
- The continued release of other ozone-depleting substances.

**(d) Identify a human activity that leads to the formation of tropospheric ozone as a secondary pollutant and explain why tropospheric ozone levels peak in the daytime.**

*(2 points: 1 point for a correct human activity and 1 point for correctly explaining that sunlight is required to form tropospheric ozone; only the first human activity can earn points)*

The following are acceptable human activities:

- Burning fossil fuels (e.g., operating motor vehicles, using landscaping equipment, electric power generation, industrial production)
- Releasing VOCs (e.g., pumping gas, using solvent-based paints)

The following are acceptable explanations for why tropospheric ozone levels peak in the daytime:

- Sunlight is required to form tropospheric ozone
- Tropospheric ozone is created by photochemical reactions

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**Question 3 (continued)**

**(e) Identify one negative ecological impact and one negative human health impact that result from the formation of tropospheric ozone.**

*(2 points: 1 point for a correct negative ecological impact and 1 point for a correct negative human health impact; only the first impact in each category can earn points)*

The following are acceptable negative ecological impacts:

- Damages plant tissue
- Reduces primary productivity/inhibits photosynthesis
- Stresses plants, making them more vulnerable to disease and pests
- Irritates the respiratory system of animals
- The statement that ozone is a greenhouse gas or contributor to climate change/global warming, along with an associated negative ecological impact (e.g., habitat loss, loss of biodiversity, shifting biomes)

The following are acceptable negative human health impacts:

- Irritates the respiratory system (e.g., throat irritation, coughing, decreased lung function)
- Associated with diseases of the respiratory system (e.g., asthma, bronchitis, etc.)
- Irritates eyes
- The statement that ozone is a greenhouse gas, or contributor to climate change/global warming, along with an associated negative human health impact (e.g., increased range of disease vectors resulting in increased mortality, increased risk of harm from severe weather events, increased hunger resulting from decreased crop yields)

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## Question 4

**(a) Describe TWO characteristics shared by ecosystems that have high biodiversity.**

*(2 points: 1 point for each description of a characteristic)*

- Large number of different species
- Large number of individuals of different species
- Complex food webs
- Greater genetic diversity
- Variety of ecological roles / niches
- Abundant resources

**(b) Identify TWO specific human activities that result in a loss of biodiversity and explain how each activity lowers biodiversity.**

*(4 points: 1 point for each activity and 1 point for each correctly linked explanation)*

Activity	Explanation
Clearing land for construction/homes/roads	<ul style="list-style-type: none"> <li>• Reduces habitat for many species</li> <li>• Results in habitat fragmentation</li> </ul>
Logging/clear cutting/deforestation	<ul style="list-style-type: none"> <li>• Reduces habitat for many species</li> <li>• Results in habitat fragmentation</li> </ul>
Agriculture: <ul style="list-style-type: none"> <li>• Monoculture</li> <li>• GMOs</li> <li>• Clearing forests to create pastureland</li> <li>• Pesticide use</li> </ul>	<ul style="list-style-type: none"> <li>• Eliminates native species; decreases genetic variation</li> <li>• Reduces habitat for many species</li> <li>• Eliminates native species and beneficial organisms</li> </ul>
Overfishing/hunting (overhunting)/poaching	<ul style="list-style-type: none"> <li>• Reduces keystone species</li> <li>• Reduces top predators</li> <li>• Depletes endangered species</li> </ul>
Water contamination by: <ul style="list-style-type: none"> <li>• Excess fertilizer</li> <li>• Runoff from feedlots</li> <li>• Runoff from construction</li> <li>• Untreated sewage</li> </ul>	<ul style="list-style-type: none"> <li>• Overloads sediments and nutrients</li> <li>• Decreases dissolved oxygen (only certain species can survive)</li> </ul>
Burning of fossil fuels	<u>Climate change</u> <ul style="list-style-type: none"> <li>• Death of coral reefs</li> <li>• Loss of reef habitat</li> <li>• Increases sea level with resulting loss of coastal habitat</li> </ul> <u>Acid rain</u> <ul style="list-style-type: none"> <li>• Increases acidity of freshwater systems (only certain species can survive)</li> </ul>
Introduction of invasive species	<ul style="list-style-type: none"> <li>• Displaces native species</li> </ul>
Dams/hydroelectric plants	<ul style="list-style-type: none"> <li>• Fragments habitat</li> </ul>
Surface mining	<ul style="list-style-type: none"> <li>• Destroys habitat</li> </ul>

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**Question 4 (continued)**

**(c) For each human activity you discussed in (b), propose a practical strategy (other than simply banning the activity) to reduce the loss of biodiversity.**

*(2 points: 1 point for each reasonable solution correctly linked to the activity or explanation in part b)*

Activity (or explanation) from part (b)	Solution
Clearing land for construction/homes/roads	<ul style="list-style-type: none"> <li>• Cluster development</li> <li>• Smart Growth planning</li> <li>• Develop urban boundaries</li> <li>• Habitat-conservation areas</li> </ul>
Logging/clear cutting/deforestation	<ul style="list-style-type: none"> <li>• Replant trees</li> <li>• Selective cutting</li> </ul>
Agriculture: <ul style="list-style-type: none"> <li>• Monoculture</li> <li>• GMOs</li> <li>• Clearing forests to create pastureland</li> <li>• Pesticide use</li> </ul>	<ul style="list-style-type: none"> <li>• Encourage polyculture, agroforestry, intercropping</li> <li>• Require GMO crops to be sterile</li> <li>• Create wildlife/habitat corridors</li> <li>• Grow shade-tolerant crops</li> <li>• Implement IPM techniques, biological pest controls</li> </ul>
Overfishing/hunting (overhunting)/poaching	<ul style="list-style-type: none"> <li>• Regulate activities and/or establish quotas</li> <li>• Enforce existing laws (ESA)</li> <li>• Ban trade (CITES)</li> </ul>
Water contamination by: <ul style="list-style-type: none"> <li>• Excess fertilizer</li> <li>• Runoff from feedlots</li> <li>• Runoff from construction</li>   <li>• Untreated sewage</li> </ul>	<ul style="list-style-type: none"> <li>• Regulate non-point sources of water pollution (e.g., buffer zones, swales, containment ponds, storm water treatment areas)</li>   <li>• Secondary or tertiary treatment</li> </ul>
Burn fossil fuels	<u>Climate change</u> <ul style="list-style-type: none"> <li>• Implement the Kyoto Protocol</li> <li>• Carbon sequestration</li> <li>• Carbon cap-and-trade</li> <li>• Carbon tax</li> <li>• Switch to renewable energy sources</li> </ul> <u>Acid rain</u> <ul style="list-style-type: none"> <li>• Require scrubbers on coal burning power plants</li> <li>• Switch to renewable energy sources</li> </ul>
Introduction of invasive species	<ul style="list-style-type: none"> <li>• Checkpoints for agricultural inspections</li> <li>• Tighter enforcement on import of horticultural or exotic species</li> <li>• Education regarding strategies to prevent invasives</li> </ul>
Dams/hydroelectric plants	<ul style="list-style-type: none"> <li>• Steps to allow fish migration</li> </ul>
Surface mining	<ul style="list-style-type: none"> <li>• Enforce Surface Mining and Reclamation Act</li> </ul>

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**Question 4 (continued)**

**(d) Describe ONE naturally occurring factor that could lead to a loss of biodiversity.**

*(1 point)*

- Particulates from asteroids/volcanoes can alter the atmosphere (e.g., block sunlight, resulting in cooler temperatures and reduced photosynthesis)
- Widespread wildfires can wipe out small populations
- Natural, long-term climate change can result in warmer or cooler temperatures
- Hurricanes/tsunamis can wipe out coastal nursery/estuary areas
- Droughts (e.g., food source may be lost; populations may be unable to adapt to drier conditions)
- Mutation/evolution may lead to new diseases/predators

**(e) Describe TWO ecological benefits that greater biodiversity provides.**

*(2 points: 1 point for each ecological benefit)*

- Pollination (by insects and other organisms)
- Water/air filtration by intact ecosystems
- Stability/survivability of ecosystems
- Control of pest species
- More source material for evolution
- Soil microorganisms can contribute to nutrient recycling, leading to higher primary productivity