

Question 4

One reason that people visit national parks is to view the scenery. Visibility at the four parks in the graph has been reduced over time so that by 2015 the visibility was an average of 70 miles less than the historical visibility. Regional air pollutant sources are commonly located over 100 miles away from national parks.

- (a) Based on the data provided in the graph, **identify** the national park that had the greatest loss of visibility as of 2015 when compared with the historical natural visibility.

(1 point for the correct identification of the national park that has had the greatest loss of visibility)

Sequoia National Park

- (b) Visibility in national parks can be affected by many different air pollutants.

- (i) **Identify** a primary air pollutant.

(1 point for the correct identification of a primary air pollutant)

- Carbon dioxide (CO₂)
- Carbon monoxide (CO)
- Nitrogen oxides (NO_x)
- Nitrous oxide (N₂O)
- Particulate Matter (PM)
- Sulfur dioxide (SO₂)
- Methane (CH₄)
- Volatile organic compounds (VOCs)

- (ii) **Describe** how a primary air pollutant becomes part of the atmosphere.

(1 point for the correct description of how a primary air pollutant becomes part of the atmosphere)

- Primary pollutants are released directly from a specific source, such as a smokestack, tailpipe, leaking pipelines, etc.
- Primary pollutants are released from the combustion of fossil fuels.
- Some pollutants (CO, PM) are a result of incomplete combustion of hydrocarbons.
- Some pollutants (methane, nitrous oxide, ammonia) are released directly from a biological source, such as cows, swamps, etc.

- (iii) **Identify** a secondary air pollutant.

(1 point for the correct identification of a secondary air pollutant)

- Ozone (O₃)
- Sulfuric acid (H₂SO₄)
- Sulfur trioxide (SO₃)
- Nitric acid (HNO₃)
- Peroxyacyl nitrates (PANs)
- Nitrogen dioxide (NO₂)
- Aldehydes

2019 SCORING GUIDELINES**Question 4 (continued)**

- (iv) **Describe** how a secondary air pollutant is formed within the atmosphere.

(1 point for the correct description of how a secondary air pollutant is formed within the atmosphere)

- Secondary air pollutants are formed when primary pollutants react with other compounds.
- Ozone (O₃) forms when primary pollutants such as NO_x and VOCs react with oxygen in the presence of sunlight.
- Sulfuric acid forms when SO_x reacts with water.
- Nitric acid forms when NO_x reacts with water.

- (c) In 1990 Great Smoky Mountains National Park had a visibility of 25 miles. Visibility data for 2015 can be determined from the graph above.

- (i) **Calculate** the percentage of increase in visibility from 1990 to 2015.

(1 point for the correct calculation of the percentage of increase in visibility from 1990 to 2015. Students are not required to show work.)

$$80\% \text{ increase in visibility } \left(\frac{45 \text{ miles} - 25 \text{ miles}}{25 \text{ miles}} \times 100 = 80\% \right)$$

- (ii) **Discuss** TWO specific actions that the state or federal government could take or encourage to further improve the visibility in Great Smoky Mountains National Park.

(2 points; 1 point for each correct and realistic discussion of a specific action the state or federal government could take or encourage to further improve the visibility in Great Smoky Mountains National Park)

- Require or offer incentives for utilities/corporations to reduce emissions by specific methods, such as cap-and-trade, pollution-prevention control devices, alternative energy sources, environmental standards on new equipment, etc.
- Limit vehicle traffic in the park through increased parking fees, free/required shuttles, HOV priority parking, etc.
- Enact stricter standards for emissions on motor vehicles.
- Offer incentives to switch from gasoline-powered vehicles to electric vehicles or natural-gas powered vehicles.
- Offer tax credits or subsidies to homeowners to increase the use of renewable energy sources.
- Limit incineration practices/prohibit campfires to reduce air pollutants.

2019 SCORING GUIDELINES**Question 4 (continued)**

(d) Excluding air pollution, **discuss** TWO additional ways national park ecosystems are being degraded by high levels of visitor use.

(2 points; 1 point for each correct discussion of an additional way national park ecosystems are being degraded by high levels of visitor use)

- Littering or inappropriate disposal of trash can negatively impact the health of wildlife.
- Littering or inappropriate disposal of trash can negatively impact water quality.
- Infrastructure construction/maintenance can result in habitat fragmentation.
- Driving or walking off road/path damages vegetation, increases erosion, or increases soil compaction.
- Noise pollution can adversely impact wildlife by disrupting mating, ranging, foraging, etc.
- Light pollution can adversely impact wildlife by disrupting mating, ranging, foraging, etc.
- Interactions with humans or pets adversely impacts wildlife by disrupting mating, ranging, foraging, etc.
- Visitors transporting nonnative species to the park results in an increase in invasive species.
- Camp fires from visitors can lead to wildfires.
- Removal of individual organisms for food, trophies, or human use can disrupt the food web.
- Water used for bathing and sanitation can lead to pollution of water resources.