

2024



AP[®] Environmental Science

Sample Student Responses and Scoring Commentary Set 2

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Free-Response Question 3

- Scoring Guidelines**
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**Question 3: Analyze an Environmental Problem
and Propose a Solution Doing Calculations****10 points**

(a) Identify a typical type of plant that would be used in a desert-tolerant landscaping. **1 point**

Accept one of the following:

- Cactus/cacti
- Succulent plants
- Drought-tolerant plants

(b) Justify the removal of landscaping and lawns that use grasses not native to the local area **1 point**
by describing an additional advantage, other than reducing the amount of water needed for irrigation.

Accept one of the following:

- Native desert plants support habitat/provide food for local/native wildlife.
- Less mowing leads to decreased yard maintenance time/costs.
- Desert tolerant plants need less fertilizer/pesticide.
- Creates jobs for landscapers to remove/replace turf.
- Decreased use of gas-powered yard tools reduces air pollution/noise pollution/gasoline consumption.

(c) Describe how a prescribed burn would reduce the severity and spread of forest fires. **1 point**

Accept one of the following:

- Prescribed burns/they remove undergrowth, decreasing fuel/flammable material.
- Prescribed burns/they thin forests/create a fire break, reducing the spread of fires.

(d) Describe a disadvantage of a prescribed burn in a forested ecosystem. **1 point**

Accept one of the following:

- Reduces habitat for wildlife/can harm or displace animals.
 - Releases carbon dioxide, which contributes to climate change.
 - Releases particulates/air pollutants, which worsens air quality.
 - Runoff following a prescribed burn can degrade water quality.
 - Reduces competition, which helps invasive species spread/expand.
-

(e) **Calculate** the number of million acre-feet (maf) of water currently in Lake Powell. **Show** your work. **1 point**

One point for the correct setup to calculate number of million acre-feet (maf) of water currently in the lake:

Accept one of the following:

- $25.16 \text{ maf} \times 36\%$
- 25.16×0.36

One point for the correct calculation of the number of million acre-feet (maf) of water currently in the lake: **1 point**

Accept one of the following:

- 9.0576
- 9.058
- 9.06
- 9.1

Total for part (e) **2 points**

(f) The watershed of the Upper Colorado River contributes an average of 9.60 maf of water to Lake Powell annually. The melted mountain snow found in the watershed contributes 50% of the average river flow into Lake Powell. In 2021, the river flow was 36% of the annual average. Assuming that all resources to that flow contributed with the same proportions as in prior years, **calculate** the amount of water (in million acre-feet) that was contributed by the melted mountain snow in 2021. **Show** your work. **1 point**

One point for the correct setup to calculate amount of water in million acre-feet that was contributed by the melted mountain snow:

Accept one of the following:

- $9.60 \text{ maf} \times 36\% \times 50\%$
- $9.60 \text{ maf} \times 0.36 \times 0.5$
- $9.60 \times 0.36 \times 0.5$

One point for the correct calculation of the amount of water in million acre-feet: **1 point**

Accept one of the following:

- 1.728
- 1.73
- 1.7

Total for part (f) **2 points**

-
- (g)** The average household in the United States consumes 5.0×10^4 gallons of water in a year. **Calculate** the number of households that could be supported for one year by the average flow of 9.60 maf of water into Lake Powell. **Show** your work. **1 point**

One point for the correct setup to calculate the number of households that could be supported for one year by the average watershed flow:

Accept one of the following:

- $9.60 \text{ maf} \times \frac{3.26 \times 10^{11} \text{ gallons}}{1 \text{ maf}} \times \frac{1 \text{ household}}{5.0 \times 10^4 \text{ gallons}}$
- $9.60 \text{ maf} \times \frac{3.26 \times 10^{11} \text{ gallons}}{5.0 \times 10^4 \text{ gallons}}$
- $9.60 \times \frac{3.26 \times 10^{11}}{5.0 \times 10^4}$

One point for the correct calculation of the number of households: **1 point**

Accept one of the following:

- 62,592,000
- 6.2592×10^7

Total for part (g) 2 points

Total for question 3 10 points

Important: Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

- a) a desert tolerant type of plant is a cactus
- b) non-native grasses often need fertilizers to grow and those fertilizers can runoff into nearby waterways. Native plants won't need fertilizers to grow in their natural habitats. Without having to use fertilizers or excess water planting native is much cheaper. ^{safely}
- c) a prescribed burn will ^vburn ~~the~~ the vegetation that has dried out in order to prevent a larger uncontrolled fire, that needs the dried vegetation to grow and spread.
- d) a disadvantage is that prescribed burns release lots of CO_2 in the atmosphere with is a greenhouse gas so it will in turn make the world warmer.
- e) ~~$36 \cdot x = 25.16$~~ $\frac{25.16}{.36} = x$ $0.36 \times 25.16 = 9.0576$ million acre feet
9.0576 million acre feet
- f) $.18 \times 9.6 = 1.728$ million acre feet ^{$.36/2 = .18$}
- g) $9.6 \times 3.26 \times 10^{11} = 3.1296 \times 10^{12}$ $3.1296 \times 10^{12} / 5 \times 10^4 = 62592000$ households

Use a pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.

Important: Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3

Begin your response to each question at the top of a new page. Do not skip lines.

~~Moss and lichens break down rock into smaller pieces using acids, leading it to form into soil.~~

(a) Cactus.

(b) The removal of non-native grasses will help prevent the spread of invasive species.

(c) A prescribed burn can safely get rid of dried plants that could have otherwise helped the spread of a forest fire.

(d) A prescribed burn could potentially spread and damage the forest ecosystem by burning trees and organisms.

(e) $25.16 \text{ maf} \times .36 = 9.0576 \text{ maf}$ of water

(f) $9.60 \text{ maf} \times .50 \times .36 = 1.728 \text{ maf}$ of water

(g) $5.0 \times 10^4 \times 9.60 = 480,000$ households

Use a pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.

Important: Completely fill in the circle that corresponds to the question you are answering on this page.

Question 1

Question 2

Question 3



Begin your response to each question at the top of a new page. Do not skip lines.

3a.) A cactus is a desert tolerant plant

3b.) It would reduce the invasive plant species and allow for native plants to inhabit the area.

3c.) A ~~prescribed~~ ^{prescribed} burn would reduce the severity of forest fires because the controlled burn would get rid of the very flammable dead brush in a safe and controlled manner

3d.) A disadvantage of a prescribed burn in a forested ecosystem would be that it would destroy essential organisms that the forest relies on or such as decomposers that decompose dead animals and have the soil take up the nutrients.

3e.) $25.16 \text{ maf} \times 0.36\% = \underline{9057600 \text{ maf}}$ currently in Lake Powell

3f.) $9,600,000 \times 0.36\% = 345,6000 \text{ maf} \times 0.15\% = \underline{518,400 \text{ maf}}$ contributed by the melting mountain snow

3g.) $\frac{9,600,000}{50,000} = \underline{1920}$ homes can be supported

Use a pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.



Question 3

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

Parts (a) and (b) required students to demonstrate understanding of ecological tolerance in desert biomes [Science Practice 1 Concept Explanation and Topics 1.2 Terrestrial Biomes, 2.4 Ecological Tolerance, and 2.6 Adaptations] and to justify the proposed solution to the overuse of water for irrigation by describing an additional benefit other than water reduction, which could be ecological, economic, cultural, or environmental [Science Practice 7 Environmental Solutions and Topics 2.2 Ecosystem Services, and 2.4 Ecological Tolerance].

In parts (c) and (d), students were expected to demonstrate an understanding of how prescribed burns are used [Science Practice 7 Environmental Solutions and Topics 2.5 Natural Disruptions to Ecosystems and 5.17 Sustainable Forestry], and the negative effects of prescribed burns on forested ecosystems, the atmosphere, or water quality. [Science Practice 7 Environmental Solutions and Topics 1.2 Terrestrial Biomes, 2.5 Natural Disruptions to Ecosystems, 5.17 Sustainable Forestry, and 7.4 Atmospheric CO₂ and Particulates].

In parts (e), (f), and (g) students were required to calculate answers associated with water volumes and flow in Lake Powell [Science Practice 6 Mathematical Routines and Topics 1.7 The Hydrologic (Water) Cycle, 2.5 Natural Disruptions to Ecosystems, and 9.5 Global Climate Change]. Part (e) required students to calculate the volume of water in Lake Powell in 2021 given the lake's capacity and the percentage full. In part (f) the students were asked to calculate the amount of water contributed to Lake Powell by mountain snowmelt given the average annual watershed contribution, the percentage from snowmelt, and the 2021 percentage of average river flow. Finally, part (g) required students to calculate the number of households that could be supported by the average flow of water into Lake Powell given the average water consumption of a household. While dimensional analysis based on unit cancellation is recommended, a setup point was earned for responses showing correct values and mathematical operations.

Sample: 3A

Score: 10

1 point was earned in part (a) for identifying “cactus.” 1 point was earned in part (b) for justifying “native plants won’t need fertilizers to grow in their natural habitats ... planting native is much cheaper.” 1 point was earned in part (c) for describing “safely burn the vegetation that has dried out in order to prevent a larger uncontrolled fire.” 1 point was earned in part (d) for describing “release lots of CO₂ in the atmosphere ... so it will in turn make the world warmer.” 2 points were earned in part (e). 1 point was earned for a correct setup, and 1 point was earned for the correct answer. 2 points were earned in part (f). 1 point was earned for a correct setup, and 1 point was earned for the correct answer. 2 points were earned in part (g). 1 point was earned for a correct setup, and 1 point was earned for the correct answer.

Question 3 (continued)

Sample: 3B

Score: 6

1 point was earned in part (a) for identifying “cactus.” No point was earned in part (b). 1 point was earned in part (c) for describing “can safely get rid of dried plants that could have otherwise helped the spread of a forest fire.” No point was earned in part (d). 2 points were earned in part (e). 1 point was earned for a correct setup, and 1 point was earned for the correct answer. 2 points were earned in part (f). 1 point was earned for a correct setup, and 1 point was earned for the correct answer. No points were earned in part (g).

Sample: 3C

Score: 3

1 point was earned in part (a) for identifying “cactus.” No point was earned in part (b). 1 point was earned in part (c) for describing “the controlled burn would get rid of the very flammable dead brush in a safe and controlled manner.” 1 point was earned in part (d) for describing a prescribed burn “would destroy essential organisms that the forest relies on such as decomposers.” No points were earned in part (e). No points were earned in part (f). No points were earned in part (g).