

2023

AP[®]



AP[®] Environmental Science

Sample Student Responses and Scoring Commentary Set 1

Inside:

Free-Response Question 3

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

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- (a) **Describe** one environmental impact on marine ecosystems associated with extraction or transportation of crude oil. **1 point**

Accept one of the following:

- Marine life is harmed/killed by being coated/suffocated by oil from spills.
- Animals are harmed/killed by ingesting spilled oil.
- Oil slicks from spills can block sunlight from entering water and inhibit photosynthesis.
- Oil that washes up on beaches/in marshes/in estuaries damages habitat.
- Noise pollution disrupts marine animals' ability to communicate/mate/eat/evade prey.
- CO₂ from combustion of fuels in boats/equipment is absorbed by ocean and contributes to ocean acidification.

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- (b) **Identify** an atmospheric pollutant released during the combustion of refined oil products. **1 point**

Accept one of the following:

- Carbon dioxide (CO₂)
- Nitrogen oxides (NO_x, NO, NO₂, N₂O)
- Sulfur oxides (SO_x, SO₂, SO₃)
- Particulate matter (PM)
- Carbon monoxide (CO)
- Volatile Organic Compounds (VOCs)

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- (c) **Propose** a solution an individual can use to reduce their reliance on refined oil products for transportation. **1 point**

Accept one of the following:

- Ride a bike/scooter/skateboard or walk instead of driving.
 - Replace a gasoline/diesel powered car with a hybrid or electric vehicle.
 - Replace a gasoline/diesel powered car with one that utilizes alternative fuel (biodiesel, ethanol, hydrogen).
 - Buy/Drive a more fuel-efficient vehicle.
 - Work from home/telecommute to reduce miles driven.
 - Choose housing that is close to employment to reduce miles driven.
 - Take public transportation instead of driving.
 - Carpool instead of driving alone.
 - Combine trips to reduce miles driven.
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(d) Justify the solution proposed in part (c) by providing a benefit to human health.

1 point

Accept one of the following:

| Solution proposed in part (c) | Justification of solution with additional advantage |
|---|--|
| <p>Replace a gasoline powered car with a hybrid or electric vehicle.</p> <p>Replace a gasoline/diesel powered car with one that utilizes an alternative fuel.</p> <p>Buy/Drive a more fuel-efficient vehicle.</p> <p>Work from home/telecommute to reduce miles driven.</p> <p>Choose housing that is close to employment to reduce miles driven.</p> <p>Take public transportation instead of driving.</p> <p>Carpool instead of driving alone.</p> <p>Combine trips to reduce miles driven.</p> | <ul style="list-style-type: none"> • Fewer air pollutants (particulates, NO_x, VOCs, smog) leads to lower rates of <ul style="list-style-type: none"> ○ respiratory illness/problems such as asthma, COPD, lung cancer. ○ cardiovascular illness such as heart attacks. ○ eye irritation. |
| <p>Ride bike/scooter/skateboard or walk instead of driving.</p> | <ul style="list-style-type: none"> • Fewer air pollutants (particulates, NO_x, VOCs, smog) leads to lower rates of <ul style="list-style-type: none"> ○ respiratory illness/problems such as asthma, COPD, lung cancer. ○ cardiovascular illness such as heart attacks. ○ eye irritation. • Improved health/Decreased risk of disease/cardiovascular illness from more physical activity/exercise. |

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- (e) A deposit is estimated to contain 260 million metric tons of gold ore. **Calculate** the number of grams of gold that could be extracted from the deposit. **Show** your work. **1 point**

One point for the correct setup to calculate the number of grams of gold that could be extracted from the gold deposit:

Accept one of the following:

- $260 \text{ million metric tons} \times \frac{5 \text{ grams}}{1 \text{ metric ton}}$
- $260 \times 10^6 \text{ metric tons} \times 5 \text{ grams}$
- $5 \times 260,000,000$

One point for the correct calculation of the number of grams of gold that could be extracted from the gold deposit: **1 point**

Accept one of the following:

- 1,300,000,000
- 1.3×10^9

Total for part (e) 2 points

- (f) Assuming the price of gold is \$62.56 per gram, **calculate** the value of the gold that could be recovered from 1,000 metric tons of gold ore in the deposit. **Show** your work. **1 point**

One point for the correct setup to calculate the value of the gold that could be recovered:

Accept one of the following:

- $\frac{\$62.56}{1 \text{ gram}} \times 1,000 \text{ metric tons} \times \frac{5 \text{ grams}}{1 \text{ metric ton}}$
- $\$62.56 \times 1,000 \text{ metric tons} \times 5 \text{ grams}$
- $\frac{\$62.56}{\text{g}} \times \frac{5 \text{ g}}{\text{metric ton}} \times 1,000$
- $1,000 \times 5 \times \$62.56$

One point for the correct calculation of the value of gold that could be recovered: **1 point**

Accept one of the following:

- \$312,800
- 312,800 dollars

Total for part (f) 2 points

-
- (g)** A typical cell phone contains 0.034 grams of gold. **Calculate** how many metric tons of gold ore would need to be mined to extract enough gold to manufacture 100,000 cell phones. **1 point**
Show your work.

One point for the correct setup to calculate the number of metric tons of gold ore that would need to be mined to manufacture 100,000 cell phones:

Accept one of the following:

- $\frac{0.034 \text{ grams}}{1 \text{ cell phone}} \times \frac{1 \text{ metric ton}}{5 \text{ grams}} \times 100,000 \text{ cell phones}$
- $\frac{0.034 \text{ grams}}{1 \text{ cell phone}} \times \frac{1 \text{ metric ton}}{5 \text{ grams}} \times 100,000$
- $0.034 \text{ grams} \times \frac{1 \text{ metric ton}}{5 \text{ grams}} \times 100,000$
- $\frac{0.034 \times 100,000}{5}$

One point for the correct calculation of the number of metric tons of gold ore that would need to be mined to manufacture 100,000 cell phones: **1 point**

- 680

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) One environmental impact on marine ecosystems because of the extraction of crude oil is the deaths of thousands of marine organisms due to oil spills during extraction. When oil spills occur, it can coat the feathers of sea birds and clog ~~the~~ fish gills. ~~This makes se~~ In cleaning off the oil, sea birds can ingest the oil and die, and fish can suffocate. Thus, many organisms die because of crude oil extraction in marine ecosystems.

B) One atmospheric pollutant created by combusting oil is NO_2 .

C) One solution an individual can use to decrease their reliance on refined oil for transportation is to bike to far locations instead of driving.

D) A benefit to human health of biking is that it decreases the amount of NO_x and VOCs produced by car exhaust. These pollutants can lead to the creation of tropospheric O_3 , which causes lung and eye irritation and can worsen respiratory illnesses like asthma.

E) $\frac{260 \text{ million metric tons of gold ore}}{1} \cdot \frac{5 \text{ grams gold}}{1 \text{ metric ton of gold ore}} = 1300 \text{ million grams of gold}$ could be extracted from the deposit

F) $\frac{1000 \text{ metric tons of gold ore}}{1} \cdot \frac{5 \text{ grams gold}}{1 \text{ metric ton of ore}} \cdot \frac{\$62.56}{1 \text{ gram gold}} = \312800 worth of gold could be recovered

G) $\frac{100,000 \text{ phones}}{1} \cdot \frac{0.034 \text{ g}}{1 \text{ phone}} \cdot \frac{1 \text{ metric ton}}{5 \text{ grams gold}} = 680 \text{ metric tons of gold ore}$ needs to be mined to make 100,000 phones

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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.

3.

(a) One ~~environmental~~ environmental impact on marine ecosystems associated with ~~extraction~~ ~~the~~ transportation of crude oil is the spilling of oil and other harmful chemicals into the ocean. The oil spilled into the ocean ~~can~~ ~~can~~ can destroy marine ecosystems by killing important species of fish or other aquatic wildlife.

(b) One atmospheric pollutant released during the combustion of oil products is CO_2 or Carbon Dioxide.

(c) A solution an individual can use to reduce their reliance on refined oil products for transportation is to walk more often rather than drive for closer distances.

(d) A benefit of walking is it can be a good source of exercise. Walking is also beneficial to heart health.

(e) $260 \text{ m} \times 5 = 1300 \text{ m} = 1.3 \text{ b}$

The number of grams of gold ~~is~~ that could be extracted from the deposit is 1.3 billion grams of gold.

(f) $1,000 \times 5 = 5,000$ $5,000 \times 62.56 = \$31,280,000$

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.

- a) The extraction or transportation of crude oil can cause an oil spill. This can leech into marine ecosystems.
- (b) Methane is released into the atmosphere.
- (c) An individual can use more public transportation.
- (d) Less oil refined oil will cause less lung cancer.
- (e) 1,300,000,000 grams of gold will be extracted.
- (f) \$327,800.00 of gold can be recovered.
- (g) 680 ~~tons~~ of metric tons of gold ore would need to be mined.

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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

This question focused broadly on natural resource extraction and impacts of extraction and use of resources on the environment and human health.

In parts (a) and (b) students were expected to demonstrate understanding of the negative effects of oil extraction, transportation, and combustion on marine ecosystems [Science Practice 1 Concept Explanation, Science Practice 7 Environmental Solutions, Topic 6.5 Fossil Fuels, Topic 7.8 Noise Pollution, and Topic 1.8 Primary Productivity] and the atmosphere [Topic 7.1 Air Pollution and Topic 7.4 Atmospheric CO₂ and Particulates].

Parts (c) and (d) required students to propose a solution that would reduce an individual's reliance on refined oil products [Science Practice 7 Environmental Solutions, Topic 6.13 Energy Conservation, Topic 6.11 Hydrogen Fuel Cell, and Topic 6.7 Energy From Biomass] and justify the solution by describing how it could also benefit human health [Science Practice 7 Environmental Solutions, Topic 7.1 Introduction to Air Pollution, Topic 7.2 Photochemical Smog, and Topic 8.14 Pollution and Human Health].

In parts (e), (f), and (g) students were required to calculate answers associated with gold mining [Science Practice 6 Mathematical Routines and Topic 5.9 Impact of Mining]. Part (e) required students to calculate the amount of gold that could be extracted from ore of a given mass and gold concentration. In part (f) the students were asked to calculate the value of gold that could be extracted from a given mass of gold ore. Finally, part (g) required students to calculate the amount of gold ore that would have to be extracted to manufacture a large volume of a consumer electronic product (cell phones) [Topic 8.9 Solid Waste Disposal]. 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

One point was earned in part (a) for describing “deaths ... of marine organisms ... oil spills ... coat the feathers of sea birds” as an environmental impact associated with extraction or transportation of crude oil. One point was earned in part (b) for identifying “NO₂” as an atmospheric pollutant released during the combustion of refined oil products. One point was earned in part (c) for proposing “to bike to far locations instead of driving” as a solution an individual can use to reduce their reliance on refined oil products for transportation. One point was earned in part (d) for justifying the solution in part (c) by providing “biking ... decreases ... NO_x and VOCs ... which causes lung and eye irritation” as a benefit to human health. Two points were earned in part (e). One point was earned for the correct setup, and 1 point was earned for the correct answer. Two points were earned in part (f). One point was earned for the correct setup, and 1 point was earned for the correct answer. Two points were earned in part (g). One point was earned for the correct setup, and 1 point was earned for the correct answer.

Question 3 (continued)

Sample: 3B

Score: 6

No point was earned in part (a). One point was earned in part (b) for identifying “CO₂” as an atmospheric pollutant released during the combustion of refined oil products. One point was earned in part (c) for proposing “walk more often rather than drive” as a solution an individual can use to reduce their reliance on refined oil products for transportation. One point was earned in part (d) for justifying the solution in part (c) by providing “walking ... can be a good source of exercise ... is also beneficial to heart health” as a benefit to human health. Two points were earned in part (e). One point was earned for the correct setup, and 1 point was earned for the correct answer. One point was earned in part (f). One point was earned for the correct setup, but no point was earned for the answer. No points were earned in part (g).

Sample: 3C

Score: 2

No point was earned in part (a). No point was earned in part (b). No point was earned in part (c). No point was earned in part (d). One point was earned in part (e). No point was earned for the setup, and 1 point was earned for the correct answer. No points were earned in part (f). One point was earned in part (g). No point was earned for the setup, and 1 point was earned for the correct answer.