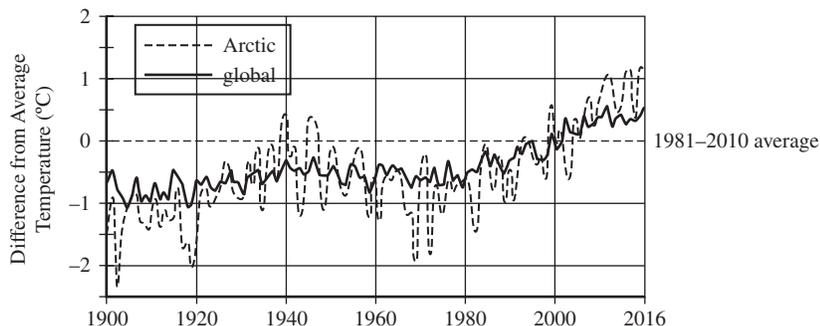




Question 2: Analyze an Environmental Problem and Propose a Solution

The graph below shows temperature anomalies from 1900 to 2016 globally and in the Arctic.

CHANGES IN AVERAGE TEMPERATURE, 1900–2016



- (a) Refer to the graph above to answer the following questions.
- Based on the data in the graph, **identify** the change in the difference from average temperature in the Arctic between 1980 and 2016.
 - Describe** the difference in the change in temperatures in the Arctic with the change in global temperatures from 2000 to 2016.
- (b) The cause of the temperature trend seen in the map is a result of increasing concentrations of greenhouse gases in the atmosphere.
- Identify** a greenhouse gas that has a global warming potential (GWP) that is greater than 1.
 - Identify** an anthropogenic source that contributes to greenhouse gas emissions.
 - Explain** how increasing amounts of greenhouse gases in the atmosphere are linked to a change in pH of the ocean.
- (c) Greenhouse gases can pose threats to both human health and the environment.
- Describe** TWO impacts that global climate change can have on human health.
 - Describe** one effect global climate change can have on marine organisms.
- (d) In order to reduce the effect of greenhouse gases on ecosystems, greenhouse gas emissions must be reduced.
- Propose** one realistic solution to reduce greenhouse gas emissions.
 - Justify** how the solution posed in (d)(i) would lead to a decrease in greenhouse gas emissions.

Scoring Guidelines for Question 2: Analyze an Environmental Problem and Propose a Solution

10 points

Learning Objectives: STB-4.D STB-4.E STB-4.F STB-4.G STB-4.H

General Scoring Note

When scoring questions with multiple correct answers, only score the first response given.

(a)	i. Based on the data in the graph, identify the change in the difference from average temperature in the Arctic between 1980 and 2016.	1 point
	<ul style="list-style-type: none">Increased 1.5 degrees C	5.A STB-4.F
	ii. Describe the difference in the change in temperatures in the Arctic with the change in global temperatures from 2000 to 2016.	1 point
	<ul style="list-style-type: none">The temperature is increasing/warming faster/at a greater rate in the Arctic.	5.B STB-4.F
Total for part (a)		2 points
(b)	i. Identify a greenhouse gas that has a global warming potential (GWP) that is greater than 1.	1 point
	Accept one of the following: <ul style="list-style-type: none">Chlorofluorocarbons (CFCs)/Hydrofluorocarbons (HFCs)Methane (CH₄)Nitrous Oxide (N₂O)	1.A STB-4.D
	ii. Identify an anthropogenic source that contributes to greenhouse gas emissions.	1 point
	Accept one of the following: <ul style="list-style-type: none">Burning of fossil fuelsDeforestation/Land use changesLivestock fermentation (methane release) and waste managementUse of CFCs in products such as refrigeration systems, air conditioners, and manufacturingUse of fertilizer	1.A STB-4.D
	iii. Explain how increasing amounts of greenhouse gases in the atmosphere are linked to a change in pH of the ocean.	1 point
	<ul style="list-style-type: none">Increased global temperature leads to increased ocean acidification because more CO₂ is absorbed by ocean waters which decreases the pH of the ocean water.	5.C STB-4.H
Total for part (b)		3 points

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(c) i. Describe TWO impacts that global climate change can have on human health.

2 points

One point each for the following (max 2):

- Increase in spread of vector diseases as habitat moves from tropics to poles.
- Increase in algal blooms and waterborne diseases from increased water temperature.
- Increase in exposure to extreme heat and cold/increase risk of illness and death from exposure to increased extreme temperatures.
- Increase in chronic conditions (cardiovascular disease, respiratory disease, etc.) from prolonged exposure to temperature extremes.
- Decrease in air quality leading to increased respiratory and cardiovascular diseases (i.e. asthma)
- Decreased water quality leading to contact with contaminated drinking water/water used for recreation/water used for sanitation
- Decreased food security/disruption to available food/disruption to access to food.

7.A

STB-4.E

ii. Describe one effect global climate change can have on marine organisms.

1 point

Accept one of the following:

- Ocean warming can lead to loss of habitat for marine species.
- Ocean warming can alter metabolic rates (increase) for marine species.
- Ocean warming can alter reproductive rates and sex ratios in certain species.
- Ocean warming can cause coral bleaching/loss of algae within corals
- Ocean warming may cause organisms, such as fish, to migrate toward the poles where water is cooler.

7.A

STB-4.G

Total for part (c)

3 points

(d) i. Propose one realistic solution to reduce greenhouse gas emissions.

1 point

Accept one of the following:

- Use more energy efficient vehicles/decrease driving distances
- Decrease electricity use to decrease reliance on fossil fuels
- Use less heat/less air conditioning to reduce amount of energy to heat/cool home.
- Switch from fossil fuel generated electricity to electricity generated from renewable sources
- Harvest methane from landfills for energy generation
- Sequester carbon through planting vegetation/reinjection
- Decrease use of plastics/fertilizers/products that require fossil fuels for production
- Decrease purchasing of products with plastic packaging
- Reduce meat consumption/switch to a vegetarian or vegan diet

7.E

STB-4.H

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ii. **Justify** how the solution posed in (d)(i) would lead to a decrease in greenhouse gas emissions.

1 point

Accept any of the following justifications.

7.F

STB-4.H

Solution proposed in (d)(i)	Justification of how solutions will reduce greenhouse gas emissions
Use more energy efficient vehicles/decrease driving distances.	<ul style="list-style-type: none">Using more energy efficient vehicles or decreasing driving distances will decrease the amount of fossil fuels burned, which will decrease the amount of greenhouse gases, such as carbon dioxide, released into the atmosphere
Use less heat/less air conditioning to reduce amount of energy to heat/cool home.	<ul style="list-style-type: none">Decreasing the use of electric heat/air conditioning will decrease the amount of fossil fuels burned for electricity generation, which will decrease the amount of greenhouse gases, such as carbon dioxide, released into the atmosphere
Decrease electricity use to decrease reliance on fossil fuels.	<ul style="list-style-type: none">Decreasing the use of electricity used will decrease the amount of fossil fuels burned for electricity generation, which will decrease the amount of greenhouse gases, such as carbon dioxide, released into the atmosphere
Switch from fossil fuel generated electricity to electricity generated from renewable sources	<ul style="list-style-type: none">Renewable sources, such as solar or wind power, do not release greenhouse gases. Switching energy source will decrease the amount of fossil fuels burned, which will decrease the amount of greenhouse gases, such as carbon dioxide, released into the atmosphere
Harvest methane from landfills for energy generation	<ul style="list-style-type: none">The methane gas released from landfills can be collected and used for energy generation, which reduces the amount of methane released to the atmosphere
Sequester carbon through planting vegetation/reinjection	<ul style="list-style-type: none">Trees and other plants absorb carbon dioxide through photosynthesis which will decrease the amount of carbon dioxide in the atmosphere.Greenhouse gases, such as carbon dioxide and hydrogen sulfide, can be captured and injected into geothermal reservoirs, reducing the amount of greenhouse gases in the atmosphere.
Decrease use of plastics/fertilizers/products that require fossil fuels for production	<ul style="list-style-type: none">Products such as plastics and fertilizers are made using fossil fuels so reducing in purchasing these products will decrease the demand for fossil fuels in production, which decreases the amount of greenhouse gases released into the atmosphere.Plastics releases several greenhouse gases as they degrade. Purchasing fewer plastics will decrease the amount of plastics in landfills and decrease the release of greenhouse gases into the atmosphere during degradation.
Decrease purchasing of products with plastic packaging	<ul style="list-style-type: none">Plastics releases several greenhouse gases as they degrade. Purchasing fewer plastics will decrease the amount of plastics in landfills and decrease the release of greenhouse gases into the atmosphere during degradation.
Reduce meat consumption/switch to a vegetarian or vegan diet	<ul style="list-style-type: none">Raising livestock produce large amounts of greenhouse gas emissions, specifically methane (from gut fermentation). Decomposition of manure from these operations also releases large amounts of CO₂ and/or methane so a reduction in meat consumption or switching to a vegetarian or vegan diet could significantly reduce the amount of greenhouse gasses emitted into the atmosphere.

Total for part (d)

2 points

Total for question 2

10 points

Question 3: Analyze an Environmental Problem and Propose a Solution Doing Calculations

An individual has decided to convert a grassy area on property to a large garden in order to grow food, primarily vegetables. The garden measures 50 meters in length by 7 meters in width.

- (a) **Describe** one environmental advantage of producing food locally.
- (b) Vegetable production in the garden was less than expected for the season.
 - i. **Identify** one soil property that affects crop production.
 - ii. The gardener applied a synthetic fertilizer to the garden for the next growing season. **Describe** one benefit of using synthetic fertilizer in the garden.
 - iii. A neighbor proposes using compost rather than a synthetic fertilizer on the garden, stating that composting is a more sustainable agricultural practice. **Justify** this claim.
- (c) The gardener finds a synthetic fertilizer with 34% nitrogen and a recommended application rate of 1 kg of nitrogen per 70.0 square meters. **Calculate** the number of kilograms of synthetic nitrogen fertilizer that should be spread on the garden area. **Show** your work.
- (d) The gardener also finds a local compost source with 2.5% nitrogen. **Calculate** the number of kilograms of compost that would need to be added to the garden to provide as much nitrogen as using the synthetic fertilizer. **Show** your work.
- (e) The price of a kilogram of synthetic fertilizer is \$3.11, while the price of a kilogram of compost is \$0.04. **Calculate** the savings to provide 1 kg of nitrogen per 70 square meters using compost rather than nitrogen. **Show** your work.

Scoring Guidelines for Question 3: Analyze an Environmental Problem and Propose a Solution Doing Calculations

5 points

Learning Objectives: **STB-1.A** **STB-3.M** **ERT-4.C** **EIN-2.D**

- (a) Describe** one environmental advantage of producing food locally. **1 point**
- Accept one of the following:
- reduced atmospheric CO₂ emissions from fewer trucks transporting food
 - reduced fossil fuel consumption from fewer trucks transporting food
 - increased genetic diversity of crops/increased biodiversity
 - ability to improve soil quality and nutrients
 - increased food security
- 7.C**
STB-1.A

Total for part (a) 1 point

- (b) i. Identify** one soil property that affects crop production. **1 point**
- Accept one of the following:
- Soil texture
 - Organic matter content
 - pH
 - Water holding capacity
- 1.A**
ERT-4.C

- ii. Describe** one benefit of using synthetic fertilizer in the garden. **1 point**
- Accept one of the following:
- The nutrients in synthetic fertilizers are readily available and can be taken up by the plant in a short period of time (days, not weeks).
 - Synthetic fertilizers are formulated to have a certain ratio of nutrients, so only the limited nutrient(s) can be added to the soil.
 - Synthetic fertilizers are inexpensive and easily available
- 7.C**
EIN-2.D

- iii. A neighbor proposes using compost, rather than a synthetic fertilizer on the garden, stating that composting is a more sustainable agricultural practice. Justify** this claim. **1 point**
- Accept one of the following:
- Production of synthetic fertilizer production requires the burning of fossil fuels and composting does not
 - Compost maintains soil porosity, which limits runoff and synthetic fertilizers do not
 - Compost reduces the amount of waste generated by using food scraps, paper, and yard wastes to create the organic fertilizer.
 - Composting reduces the amount of atmospheric methane since there is less food waste decomposing in landfills
 - Compost can be produced on site and does not require transportation (less CO₂, less fossil fuel combustion)
- 7.F**
STB-3.M

Total for part (b) 3 points

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- (c) Calculate** the number of kilograms of synthetic nitrogen fertilizer that should be spread on the garden area. **Show** your work. **2 points**
- One point for correct setup to calculate the number of kg of synthetic N fertilizer
- Garden area = 50 m x 7 m = 350 m²

$$350 \text{ m}^2 \times \frac{1 \text{ kg}}{70 \text{ m}^2}$$

One point for the correct calculation of the number of kg of synthetic N fertilizer

- Fertilizer amount = 5.0 kg

Total for part (c) 2 points

- (d) Calculate** the number of kilograms of compost that would need to be added to the garden to provide as much nitrogen as using the synthetic fertilizer. **Show** your work. **2 points**
- One point for the correct setup to calculate the number of kg of compost
- 5 kg fertilizer $\times \frac{0.34 \text{ N}}{1 \text{ kg fertilizer}} \times \frac{1 \text{ kg compost}}{0.025 \text{ N}}$ OR $\frac{0.34 \text{ N in fertilizer}}{0.025 \text{ N in compost}} \times 5.0 \text{ kg fertilizer}$

One point for the correct calculation of the number of kg of compost

- Compost amount = 68 kg

Total for part (d) 2 points

- (e) Calculate** the savings to provide 1 kg of nitrogen per 70 square meters using compost rather than nitrogen. **Show** your work. **2 points**
- One point for the correct setup to calculate the amount of savings
- Price of synthetic fertilizer = $\frac{\$3.11}{\text{kg fertilizer}} \times 5 \text{ kg fertilizer} = \15.55

One point for the correct calculation of the amount of savings

- Price of compost = $\frac{\$0.04}{\text{kg compost}} \times 68 \text{ kg compost} = \2.72

Difference in cost: $\$15.55 - \$2.72 = \$12.83$ per kg

NOTE: If the student did not correctly calculate part (c) and/or part (d), the response for part (e) can earn points if the incorrect values were used correctly in the equations in part (e).

Total for part (e) 2 points

Total for question 3 10 points