

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

10 points

(a) **Identify** a fuel used in a nuclear power plant. 1 point

Accept one of the following:

- Uranium
- U-235
- Plutonium

(b) **Describe** a negative environmental impact on nearby bodies of water that is caused by using water for cooling in nuclear power plants. 1 point

Accept one of the following:

- Thermal pollution raises water temperature outside range of tolerance of organisms.
- Thermal pollution decreases dissolved oxygen.
- Water temperature increases, which decreases dissolved oxygen.
- Organisms can be wounded or killed at water intake.
- Water loss through evaporation can decrease stream flow/volume of water.

(c) In 2021, 4.1×10^{12} kilowatt hours (kWh) of commercial electricity was generated in the United States. Nuclear power accounted for 18.9% of the total commercial electricity. **Calculate** the amount of electricity in kWh generated by nuclear power in the United States in 2021. **Show** your work. 1 point

One point for the correct setup to calculate the amount of electricity generated by nuclear power in 2021:

Accept one of the following:

- $(4.1 \times 10^{12} \text{ kWh}) \times 18.9\%$
- $(4.1 \times 10^{12}) \times 0.189$
- $\frac{4.1 \times 10^{12}}{100} = \frac{x}{18.9}$

One point for the correct calculation of the total amount of electricity generated by nuclear power in 2021: 1 point

Accept one of the following:

- 774,900,000,000
- 7.749×10^{11}
- 7.75×10^{11}
- 7.7×10^{11}

Total for part (c) 2 points

(d)	In addition to reducing greenhouse gas emissions, describe how switching from coal-burning power plants to natural gas power plants will improve air quality. There is less NO_x/SO_x/ash/particulates/toxic metals/smog formed from the burning of natural gas compared to coal.	1 point
(e)	Justify the proposed solution by explaining an additional advantage, other than the reduction of atmospheric greenhouse gases. Accept one of the following: - Trees can provide forest habitat/increase biodiversity/diversify niches in the area. - Creates jobs for planting trees/recreational industries/harvesting wood. - Trees create a more aesthetically pleasing environment/enhance cultural ecosystem services. - Planting trees can decrease soil loss/erosion/sedimentation in waterways. - Trees can provide shade/decrease ambient temperature. - Planting trees slows water runoff/reduces flooding.	1 point
(f)	7.4×10^7 cubic meters of natural gas were extracted from a large deposit in 2020. An average of 4.76 kWh of electricity can be generated from each cubic meter of natural gas combusted. In 2020, an average home consumed 10,715 kWh of electricity. Calculate how many homes could have been provided with electricity by natural gas extracted from the large deposit in 2020. Show your work. One point for the correct setup to calculate how many homes could have been provided with electricity by natural gas: Accept one of the following: $(7.4 \times 10^7 \text{ m}^3) \times \frac{4.76 \text{ kWh}}{1 \text{ m}^3} \times \frac{1 \text{ home}}{10,715 \text{ kWh}}$ $(7.4 \times 10^7 \text{ m}^3) \times \frac{4.76 \text{ kWh}}{10,715 \text{ kWh}}$ $(7.4 \times 10^7) \times \frac{4.76}{10,715}$ One point for the correct calculation of how many homes could have been provided with electricity by natural gas: Accept one of the following: 32,874 32,873 33,000	1 point
	Total for part (f)	2 points

- (g) In 2021, 8.99×10^{11} kWh of electricity was generated through the combustion of coal. **1 point**
 One kilogram of carbon dioxide is produced per kWh of electricity generated by combusting coal, while 0.42 kilograms of carbon dioxide is produced by combusting natural gas. **Calculate** how much less carbon dioxide would have been produced in 2021 if all coal-burning power plants were replaced with natural gas-burning power plants. **Show** your work.

One point for the correct setup to calculate how much less carbon dioxide would have been produced in 2021:

Accept one of the following:

- $\frac{(1.0 \text{ kg} - 0.42 \text{ kg})}{1 \text{ kWh}} \times (8.99 \times 10^{11} \text{ kWh})$
- $(1.0 \text{ kg} - 0.42 \text{ kg}) \times (8.99 \times 10^{11} \text{ kWh})$
- $(1.0 - 0.42) \times (8.99 \times 10^{11})$
- $\left(\frac{8.99 \times 10^{11} \text{ kWh}}{1} \times \frac{1 \text{ kg}}{\text{kWh}} \right) - \left(\frac{8.99 \times 10^{11} \text{ kWh}}{1} \times \frac{0.42 \text{ kg CO}_2}{\text{kWh}} \right)$, THEN
 $8.99 \times 10^{11} \text{ kg CO}_2 - 3.776 \times 10^{11} \text{ kg CO}_2$

One point for the correct calculation of how much less carbon dioxide would have been produced in 2021: **1 point**

Accept one of the following:

- 521 billion kg
- 521,420,000,000 kg
- $5.2142 \times 10^{11} \text{ kg}$
- $5.21 \times 10^{11} \text{ kg}$
- $5.2 \times 10^{11} \text{ kg}$

Total for part (g) 2 points

Total for question 3 10 points