

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

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- (a) **Describe** one environmental problem associated with the release of methane into the atmosphere. **1 point**

Accept one of the following:

- It traps heat effectively leading to climate change/global warming.
- The greenhouse effect is enhanced, increasing global temperatures/warming.
- It is a greenhouse gas, which leads to climate change/global warming.
- It is a greenhouse gas, which leads to melting ice/rising sea levels.

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- (b) **Describe** one factor that could affect the decomposition of the solid waste in a landfill. **1 point**

Accept one of the following:

- The amount of/percentage of organic material in the solid waste.
- The amount of/percentage of non-degradable material in the solid waste.
- Conditions of the landfill (such as concentration of oxygen, population of microbes/decomposers, temperature, moisture).
- Environmental conditions of the area (such as temperature, amount of rainfall, climate, weather, etc.).

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- (c) **Propose** a solution to decrease the amount of methane released from landfills into the atmosphere. **1 point**

Accept one of the following:

- Incinerate waste.
 - Compost waste.
 - Recycle/reuse non-synthetic organic waste (paper, textiles).
 - Install/Use methane collection systems.
 - Burn off/Combust the methane coming from the landfill.
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- (d) **Justify** the solution proposed in part (c) by describing an additional advantage, other than decreasing the amount of methane released from landfills. **1 point**

Accept one of the following:

Solution proposed in part (c)	Justification of solution with additional advantage
Incinerate waste.	• Extends the lifetime of the landfill. • Reduces the amount of waste going to the landfill. • Can be used to generate electricity/heat. • Can generate income. • Reduces land area needed for landfills.
Compost waste.	• Extends the lifetime of the landfill. • Produces effective, inexpensive fertilizer. • Reduces land area needed for landfills.
Recycle/Reuse non-synthetic organic waste (paper, textiles, etc.).	• Reduces land needed for landfills. • Reduces energy/resources needed for new products. • Reduces trees cut for new paper.
Install/Use methane collection systems. Burn off/Combust the methane coming from the landfill.	• Can be used to generate electricity. • Can be used to heat buildings. • Can generate income. • Can be used as fuel. • Reduces the need for other energy sources.

- (e) The average cow releases 150 liters of methane per day. **Calculate** the amount of methane that was released by all beef cattle raised in the United States in one year. **Show** your work. **1 point**

One point for the correct setup to calculate the amount of methane released in one year:

Accept one of the following:

- $\frac{150 \text{ L methane per day}}{\text{cow}} \times 31,200,000 \text{ cows (cattle)} \times \frac{365 \text{ days}}{1 \text{ year}}$
- $31,200,000 \times \frac{150 \text{ L}}{\text{cow}} \times 365 \text{ days}$
- $150 \times 31,200,000 \times 365$

One point for the correct calculation of the amount of methane released in one year: **1 point**

Accept one of the following:

- 1,708,200,000,000 L
- 1.7×10^{12} L

Total for part (e) 2 points

- (f) A typical beef cow needs 11.8 kilograms of food per day and each hectare of cattle pasture produces 26.2 kilograms of grasses. **Calculate** the number of hectares of pasture that would be needed to support all beef cattle raised in the United States for one day. **Show** your work. **1 point**

One point for the correct setup to calculate the number of hectares of pasture to support cattle:

Accept one of the following:

- $\frac{11.8 \text{ kg}}{\text{cow}} \times \frac{1 \text{ ha}}{26.2 \text{ kg}} \times 31,200,000 \text{ cows (cattle)}$
- $31,200,000 \times \frac{11.8 \text{ kg}}{26.2 \text{ kg}}$
- $\frac{11.8}{26.2} \times 31,200,000$

One point for the correct calculation of the number of hectares of pasture to support cattle: **1 point**

Accept one of the following:

- 14,051,908
- 1.4×10^7
- 14.1 million

Total for part (f) 2 points

- (g) The average American consumes 2,250 kilocalories of food per day. Beef cattle can produce 2.7 million kilocalories per hectare of land. Corn can produce 30.4 million kilocalories per hectare of land. **Calculate** how many more American people could be fed if 150 hectares of land was used to grow corn instead of raising beef cattle. **Show** your work. **1 point**

One point for the correct setup to calculate the change in the number of people:

Accept one of the following:

- $\frac{(30,400,000 \text{ kcal} - 2,700,000 \text{ kcal})}{1 \text{ ha}} \times \frac{1 \text{ person}}{2,250 \text{ kcal}} \times 150 \text{ ha}$
- $(30,400,000 - 2,700,000) \times \frac{1 \text{ person}}{2,250 \text{ kcal}} \times 150$
- $\left(\frac{30,400,000}{2,250} \times 150 \right) - \left(\frac{2,700,000}{2,250} \times 150 \right)$
- $\frac{(30,400,000 - 2,700,000)}{2,250} \times 150$

One point for the correct calculation of the change in the number of people: **1 point**

Accept one of the following:

- 1,846,667
- 1.8×10^6

Total for part (g) 2 points

Total for question 3 10 points