3. Human activities generate large amounts of solid waste, including organic waste. The decomposition of organic waste in landfills can result in the release of methane into the atmosphere.

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

There are biological and physical factors that can affect the decomposition of the solid waste in a landfill and the release of methane in the atmosphere.

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

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

(d) **Justify** the solution proposed in part (c) by describing an additional advantage, other than decreasing the amount of methane released from landfills.

Another anthropogenic activity that releases methane is raising beef cattle. In 2021, 31.2 million beef cattle were raised in the United States.

(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 2021. **Show** your work.

Another environmental concern with raising beef cattle for food is that it is not as efficient as growing crops for food.

(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.

(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.

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**Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.**

**STOP**

**END OF EXAM**





3. North Carolina is one of the fastest-growing states by population in the United States, with most growth concentrated in major cities like Charlotte. Increased population leads to increased demands for resources such as power and water.

The majority of electrical energy in North Carolina is produced during the combustion of coal.

(a) **Identify** one negative human health effect linked to the exposure to pollutants resulting from the combustion of coal.

(b) Coal ash, the powdery, solid substance that remains after coal combustion, presents a variety of potential environmental issues. Disposal of toxic coal ash is a growing concern in the state. Coal ash can be mixed with water and disposed of in large, unlined pits or as dry ash in landfills.

(i) **Describe** an environmental problem associated with coal ash waste disposal.
(ii) A proposed solution is to dispose of North Carolina's coal ash in clay-lined pits. **Justify** this solution by providing one advantage of using clay soil.

(c) The population of Charlotte, North Carolina, has grown over the last few decades. The table shows the increase in the population size of Charlotte from 2013 to 2019.

**Population of Charlotte, North Carolina, 2013–2019**

| Year | Population |
|---|---|
| 2013 | 757,278 |
| 2014 | 774,807 |
| 2015 | 792,137 |
| 2016 | 808,834 |
| 2017 | 826,060 |
| 2018 | 841,611 |
| 2019 | 857,425 |

(i) **Calculate** the percent change in Charlotte's population from 2013 to 2019. **Show** your work.
(ii) Based on Charlotte's 2019 growth rate of 1.88%, **calculate** the year when the population of Charlotte will double, assuming the growth rate stays the same. **Show** your work.
(iii) The average Charlotte resident uses 90 gallons of water per day. **Calculate** the gallons of water used by the population of Charlotte in the year 2018. **Show** your work.

(d) Drought periods are becoming more frequent in North Carolina, causing water resources to become more scarce. **Describe** one realistic action that citizens could take to reduce domestic outdoor water use.

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**Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.**

**STOP**

**END OF EXAM**

## ENVIRONMENTAL SCIENCE
### SECTION II
**Time—1 hour and 30 minutes**
**4 Questions**

**Directions:** Answer all four questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers on the pages following the questions in this book. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples.

1. Read the following article from the *Fremont Daily Times* and answer the questions that follow.

**Fremont Daily Times** **May 1, 2018**

**GREEN IS THE NEW SCHOOL COLOR AT FREMONT HIGH SCHOOL!**

A group of students from Fremont High School addressed the city council last night and proposed that one of the existing buildings at Fremont High School, which was built in 1970, be renovated to take advantage of recent advances in green technology. Currently the heat for the school is provided by fossil fuel combustion. The students said that the redesigned building would reduce the school's carbon footprint, which is a measure of the amount of carbon dioxide and other carbon compounds released by various human activities. Incorporating specific features that conserve energy and utilize renewable energy sources can help reduce the carbon footprint.

Councilperson Gail Fassler praised the idea, saying that the project could conserve local water resources, reduce the need for consuming new resources, and act as a "shining beacon" of sustainability for the greater Fremont community. Fassler suggested the project could even incorporate a living green roof as an additional sustainable feature. The council approved the initial site planning request and urged students to report back when the project was under way.

(a) The students want to reduce the school's carbon footprint.

(i) **Define** carbon footprint.

(ii) **Identify** one way the school's heating system is likely adding to the school's carbon footprint.

(iii) **Describe** one realistic way to reduce the contribution of the heating system to the school's carbon footprint.

(b) **Identify** TWO environmental benefits of a living green roof, such as that suggested by Councilperson Fassler.

(c) **Describe** TWO practices the cafeteria's food service could use to decrease the environmental impacts of Fremont High School.

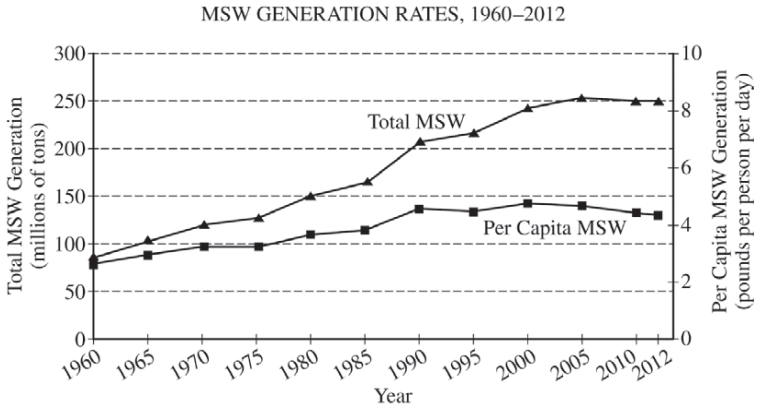
(d) **Discuss** TWO benefits of using native plants for landscaping at Fremont High School.

(e) During the renovation, the carpeting must be replaced. **Discuss** one environmental benefit of using flooring made of plant material, such as cork or bamboo, instead of carpet made of synthetic fibers.





3. Municipal solid waste (MSW) is the trash collected from households and businesses. The graph below shows MSW generation in the United States from 1960 to 2012.




(a) Use the data provided in the graph above to respond to the following.

(i) **Explain** one probable cause (other than increased composting) for the change in per capita waste generation from 2000 to 2012.

(ii) **Calculate** the percent increase in total MSW generation from 1980 to 2012.

(b) Two ways of managing MSW are incineration and disposal in landfills.

(i) **Identify** one disadvantage of waste incineration.

(ii) **Identify** one disadvantage of waste disposal in landfills.

Trash incineration is one way to generate electricity from MSW. Electricity can also be generated from waste buried in landfills.

(c) **Describe** the specific steps of a process used to produce electricity from waste buried in a landfill.

(d) Many landfills do not accept used tires. As a result, the tires are often dumped in poorly regulated piles. **Describe** one human health problem associated with piles of discarded tires.

(e) Composting is one way to reduce the amount of waste that enters a landfill.

(i) Other than reducing the volume of waste, **identify** one advantage of composting.

(ii) **Identify** one disadvantage of composting.

2. Approximately 30 million mobile devices were sold in 1998 in the United States. The number sold increased to 180 million devices in 2007.

   (a) **Calculate** the percent increase of mobile device sales from 1998 to 2007.

   (b) Each mobile device sold in 2007 contained an average of 0.03 gram of gold. **Calculate** the number of grams of gold that were used in the production of the mobile devices sold in 2007.

   (c) Assume that the average mass of each mobile device was 0.1 kilogram. The United States Environmental Protection Agency estimates that about 10 percent of the mobile devices sold in 2007 were recycled. **Calculate** the mass (in kilograms) of the mobile devices sold in 2007 that were <u>not</u> recycled.

   (d) Discarded mobile devices become part of the electronic waste stream (e-waste). Mercury is often present in e-waste. **Identify** one negative human health effect, other than death, associated with exposure to mercury.

   (e) Improper disposal of e-waste has harmed human health and caused environmental damage in developing countries.

      (i) **State** TWO reasons why large quantities of e-waste from the United States are shipped to developing countries rather than being recycled in the United States.

      (ii) Retailers or manufacturers could take specific steps to dramatically reduce the amount of e-waste. **Describe** a realistic change in current practices that would accomplish this.