AP® Environmental Science
2008 Free-Response Questions

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ENVIRONMENTAL SCIENCE
SECTION II
Time—90 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 the pink booklet. 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 article below and answer the questions that follow.

Fremont Examiner

Microalgae for Fuel Production: Can Green Goo Solve Our Energy and Climate Problems?

Scientists and investors are promoting the potential of some of the smallest, oiliest critters on Earth as a solution to our energy problems. Although the humble organisms look like green goo, some species of microalgae are over 50 percent oil. Scientists say microalgae are the most efficient organisms at converting sunlight to energy. In fact, they beat other oil crops for production per acre, hands down.

Gallons of Oil per Acre per Year	
Corn	20
Soybeans	50
Safflower	83
Sunflower	102
Rapeseed	115
Oil palm	640
Microalgae	10,000

Seventy percent of this oil can be recovered by pressing the algae; over 90 percent can be recovered by solvent extraction. The resulting oil can be used for heating, for electricity generation, or for making other fuels, like biodiesel. After the oil is removed, the remaining material can be used as animal feed or soil amendment. The Germans are even looking into using it for construction material. "In this way, we sequester that carbon indefinitely," said Dr. Klaus Mueller. Some scientists are bubbling emissions from coal-burning power plants through algae-filled tanks to remove CO_2.

Proponents claim that microalgae can be used to capture nutrients from animal feedlot waste lagoons and sewage treatment plants. Because they grow only in the top inch of water, the algae might even be grown in rooftop pools someday. But are microalgae really all they're cracked up to be? Like other monoculture crops, they may be susceptible to widespread damage from disease.

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(a) Calculate the number of acres required to produce 1,000 gallons of oil in one year from

(i) microalgae

(ii) soybeans

(b) Describe TWO environmental advantages that biodiesel production from microalgae offers over biodiesel production from the other crops listed in the table.

(c) Explain why burning biodiesel fuel has a different impact on atmospheric CO_2 concentrations than does burning fossil fuels.

(d) Discuss TWO benefits, other than those related to atmospheric impacts, of increased reliance on biodiesel fuels over the next 50 years.

(e) Describe TWO economic or societal problems associated with producing fuel from corn.

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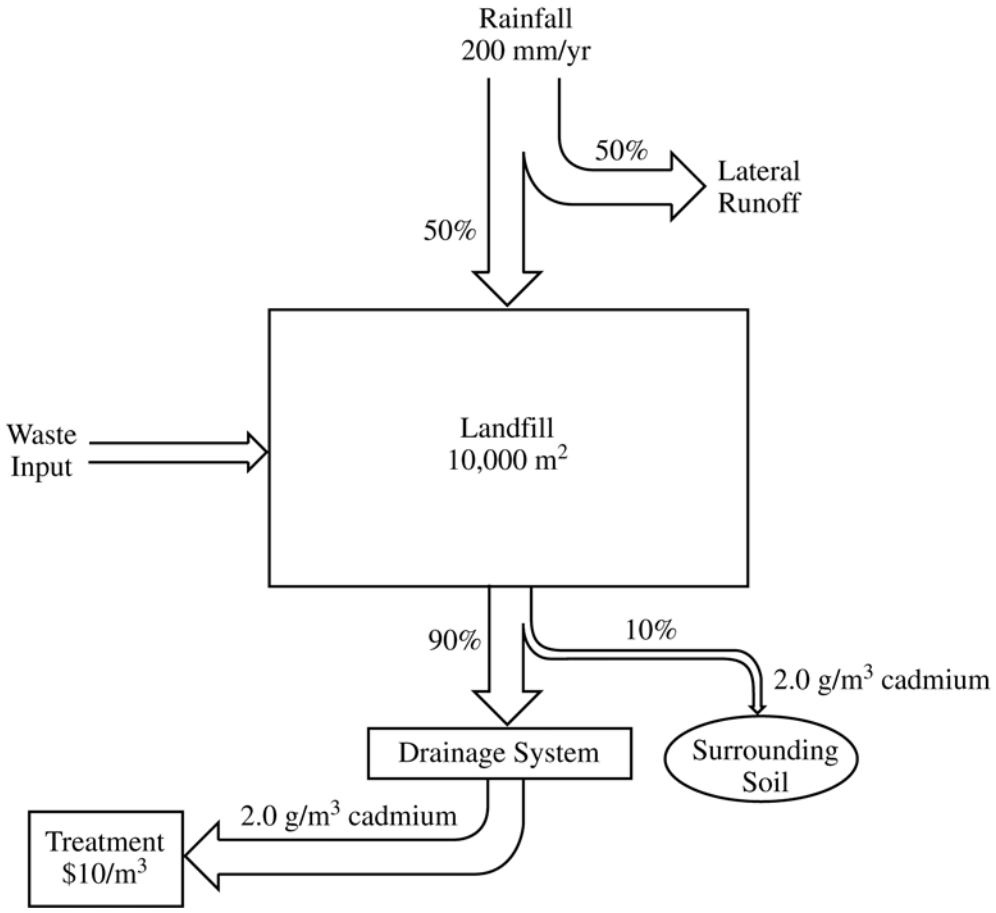

2. The city of Fremont operates a municipal solid-waste landfill. As represented in the diagram above, the annual precipitation in Fremont is 200 mm/year: 50 percent of this water infiltrates through the landfill cover soil into the waste, and 50 percent drains off the landfill. A drainage system withdraws 90 percent of the leachate generated within the landfill for treatment. The rest of the leachate travels through the bottom liner of the landfill into the surrounding soil. Most of the cadmium disposed of in the landfill remains in the landfill; the leachate withdrawn from the landfill by the drainage system has an average cadmium concentration of 2.0 g/m^3. Pumped to a treatment station, the leachate is treated at a cost of \$10/m^3.

   (a) Calculate the volume, in m^3, of each of the following:

      (i) The water infiltrated through the landfill per year

      (ii) The leachate that is treated per year

   (b) Given that the cadmium concentration in the water draining from the landfill is 2.0 g/m^3, calculate the mass, in kg, of cadmium that is released into the surrounding soil per year.

   (c) What is the annual cost of treating the leachate from the drainage system?

   (d) Discuss TWO viable methods for reducing the amount of cadmium entering the municipal waste input.

   (e) Explain a shortcoming of ONE of the methods that you identified in part (d).

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3. For decades, forest fires in the United States have been suppressed. In 2003 legislation was passed under the Healthy Forests Initiative (HFI) in response to the record-breaking wildfires that had occurred in the early 2000s. Some environmental and conservation groups fear that negative impacts could result if timber companies are encouraged to harvest medium- and large-size trees in federally owned forests while clearing away the smaller trees and underbrush.

   (a) Identify TWO characteristics of forests that develop when fires are suppressed, and explain why the practice of fire suppression does not reduce, but actually increases, the risk of intense and extensive forest fires.

   (b) The effects of the HFI are expected to extend beyond fire reduction. Excluding fire reduction, describe ONE positive and ONE negative effect likely to result from the implementation of the provisions of the HFI.

   (c) Describe TWO ecosystem services provided for humans by forests. Explain how clear-cutting would affect each ecosystem service you describe.

   (d) Identify a specific type of plant community or biome (other than a forest) that is naturally maintained by fire. Explain how the fire maintains the community or biome.

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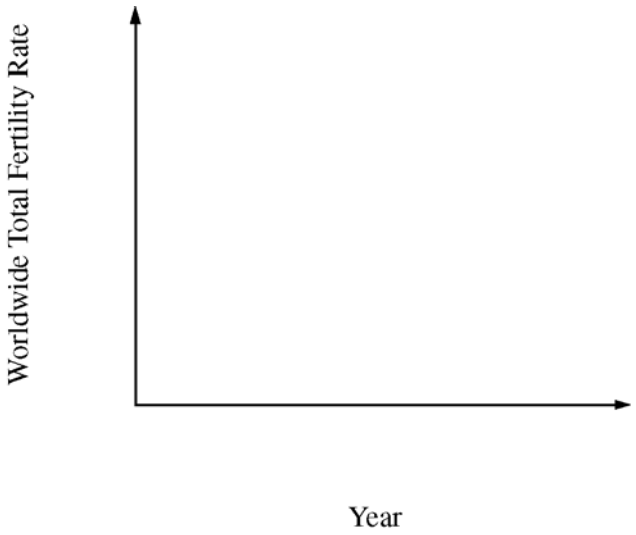
4. Answer the following regarding world human population.

(a) Create a graph of the data from table 1 below on the axes provided.

Table 1: Worldwide Total Fertility Rate (TFR)

Year	TFR
1950	5.0
1960	4.9
1970	4.7
1980	3.7
1990	3.4
2000	3.0



(b) Identify and discuss TWO of the causes for the trend in the worldwide TFR that you graphed in part (a).

Table 2: Population Data for Selected Nations (2005)

Country	TFR	Crude Birth Rate*	Crude Death Rate*	Infant Mortality Rate*	Per Capita Income (U.S. dollars)
China	1.6	12	7	27	6,500
Japan	1.3	9	8	2.8	31,400
Kenya	5.9	43	19	100	1,000
United States	2.0	14	8	6.7	42,000

* rates are per thousand per year

(c) Consider the data in table 2 above. Identify and discuss TWO economic or societal factors that account for the difference between the TFR of Kenya and that of the United States.

(d) Describe TWO human activities related to the rapidly growing world population that are having an impact on Earth's biodiversity.

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END OF EXAM