AP® Environmental Science
2008 Scoring Guidelines

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Question 1

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

(i) microalgae

(One point is earned for the correct answer.)

$$\frac{10{,}000 \text{ gal}}{1 \text{ acre}} = \frac{1{,}000 \text{ gal}}{x \text{ acres}} \qquad x = \textbf{0.1 acre}$$

OR

$$1 \text{ acre} = 10{,}000 \text{ gal}; \qquad 1{,}000 \text{ gal} \times \frac{1 \text{ acre}}{10{,}000 \text{ gal}} = \textbf{0.1 acre}$$

(ii) soybeans

(One point is earned for the correct answer.)

$$\frac{50 \text{ gal}}{1 \text{ acre}} = \frac{1{,}000 \text{ gal}}{x \text{ acres}} \Rightarrow \qquad x = \textbf{20 acres}$$

OR

$$1 \text{ acre} = 50 \text{ gal}; \qquad 1{,}000 \text{ gal} \times \frac{1 \text{ acre}}{50 \text{ gal}} = \textbf{20 acres}$$

(A third point is earned in part (a) for a correct setup of <u>both</u> the microalgae and soybean calculations.)

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Question 1 (continued)

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

(One point is earned for each correct advantage; accept only the first two advantages given. Each advantage listed must include a corresponding description.)

Advantage	Description
Less land use	• Less habitat destruction and/or less loss of biodiversity • Protection of watersheds from agricultural runoff
Decreased tilling of soil	• Less soil erosion
Decreased pesticide and/or fertilizer use	• Less runoff of pesticides and/or fertilizers
Decreased fossil fuel consumption for tilling soil, harvesting crops, and/or manufacturing and applying fertilizers and pesticides	• Less mining and drilling for fossil fuels, resulting in less habitat destruction and less loss of biodiversity • Less air pollution (e.g., NO_x, O_3)
Decreased energy consumption for extracting oils from microalgae	• Less mining and drilling for fossil fuels, resulting in less habitat destruction and less loss of biodiversity • Less air pollution (e.g., NO_x, O_3)
Decreased irrigation of land	• Less soil salinization and/or less desertification • Less aquifer depletion
Less nutrient depletion of soil	• Less land under cultivation
Microalgae may be grown in wastewater	• Less runoff and less infiltration of wastewater

Question 1 (continued)

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

(One point is earned for a correct explanation.)

Biodiesel contains carbon that was recently present in the atmosphere rather than fossil-fuel carbon that was in the atmosphere long ago and has been sequestered beneath Earth's surface. Hence the burning of biodiesel does not contribute to a net increase in the amount of carbon dioxide currently circulating in the atmosphere, whereas the burning of fossil fuel does contribute to a net increase in the concentration of carbon dioxide in the atmosphere.

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

(A total of 3 points can be earned according to the following guidelines.)

- No point is earned for one correct benefit with no appropriate discussion.
- One point is earned for one correct benefit with an appropriate discussion.
- One point is earned for two correct benefits with no appropriate discussion.
- Two points are earned for two correct benefits with one appropriate discussion.
- Three points are earned for two correct benefits with two appropriate discussions.
- Only the first two benefits mentioned in the response can earn points.
- Benefits based on speculation about future energy prices do not earn points.

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Question 1 (continued)

Benefit	Sample Discussion
Biofuels are renewable resources	• Fossil fuels are nonrenewable • Renewable resources are less likely to be exhausted
Increased jobs	• More labor needed in the agricultural sector
Increased profits for companies	• Industries in the agricultural sector will increase sales
Decreased reliance on imported fossil fuels	• Decreases political instability • Results in a self-sufficient supply of energy
Increased global political stability	• Reliance on imported fossil fuels decreases • Disputes over oil are frequently the cause of disagreements among nations
Reduced transportation costs	• Fewer oil spills during transport • Fossil fuels must be transported over greater distances
Reduced land disturbance	• Result of less fossil fuel extraction
Preservation of petroleum	• For nonenergy uses (e.g., plastics, petrochemicals, medical purposes)
Reduced insecurity as fossil fuel reserves decrease	• Enhances a shift to alternate energy sources
Reduced petroleum use	• Petroleum reserves will dwindle over the next 50 years
Increased nutrient capture from wastewater	• Less escapes into the environment • Reduced eutrophication of waterways
Increased availability of waste products	• Increased availability for use as animal feed or soil amendment
Decreased disposal of used cooking oil	• Results in less waste disposal

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Question 1 (continued)

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

(One point is earned for each correct response that includes a corresponding description; only the first two responses can earn points.)

Problem	Description
Increase (or decrease) in corn prices	• As corn is used for energy production, the demand for corn will become greater • Increased corn growing may flood market
Increased prices for food (e.g., beef, chicken, anything made with corn syrup)	• Result of increased corn prices • Increased demand for corn
Increased prices for commodities other than corn	• Increased corn production reduces land area for other crops, reducing supply of commodities
Shortages of food for human consumption	• Decreased supply of corn • Decreased availability of crops displaced by corn production
Cultural extinction	• Rainforest destruction for the production of crops displaced by corn production displaces indigenous cultures
Decreased aesthetic value of land	• Natural areas converted to farmland have less aesthetic value
Loss of jobs	• Lower demand for energy production jobs not associated with corn (e.g., coal mining, petroleum engineering)
Energy shortages	• Poor crop yields resulting from drought, pestilence, etc., result in less corn to produce energy
Increased land costs	• Due to increased demand for agricultural lands
Decreased availability of land for nonagricultural use leading to less land for cities	• Due to increased demand for agricultural lands

Question 1 (continued)

Problem	Description
Decreased availability of land for nonagricultural use leading to public opposition	• Due to increased demand for agricultural lands
Reduced water supply for cities	• Due to increased agricultural water consumption
Increased societal risks associated with exposure to agricultural chemicals	• Increased pesticide and fertilizer use
Higher costs to cultivate and maintain agricultural land	• Increased use of marginal lands to grow more corn
Overuse of agricultural land	• Loss of productive land
Increased taxes or unavailable public money	• Subsidies that divert public money to pay for corn production.
The need to convert combustion engines to burn ethanol or biodiesel	• Using corn for fuel will result in fuel that is not compatible with current engines
More expensive than alternatives	• Higher cost for resources (e.g., fertilizer, pesticides, land, water) needed to produce fuel from corn as compared with producing other fuels

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Question 2

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

(Two points can be earned in each of parts (a)(i) and (a)(ii): 1 point for a correct setup, and 1 point for the correct answer.)

(i) The water infiltrated through the landfill per year

$$200 \text{ mm rain} \times \frac{1 \text{ m}}{1{,}000 \text{ mm}} = 0.2 \text{ m rain}$$

$$\frac{10{,}000 \text{ m}^2 \mid 0.2 \text{ m} \mid \text{50\% infiltrated water}}{\mid \mid \text{100\% water}} = \mathbf{1{,}000\ m^3}$$

(ii) The leachate that is treated per year

$$1{,}000 \text{ m}^3 \times 0.9\ (90\%) = \mathbf{900\ m^3}$$

Note: If the answer to (a)(i) is incorrect, then 0.9 times that answer still earns full credit in (a)(ii).

(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.

(Two points can be earned: 1 point for the correct setup, and 1 point for the correct answer.)

Note: The student can either begin with the difference between the answers for (a)(i) and (a)(ii) or take 10 percent of the answer from (a)(i). Metric conversions do not necessarily have to be shown.

$$\frac{100 \text{ m}^3 \text{ drainage water} \mid 2.0 \text{ g Cd} \mid 1 \text{ kg}}{1 \text{ year} \mid 1 \text{ m}^3 \mid 1{,}000 \text{ g}} = \mathbf{0.2\ kg\ Cd/year}$$

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

(Two points can be earned: 1 point for the correct setup, and 1 point for the correct answer.)

Note: The student must use the answer from (a)(ii).

$$\frac{900 \text{ m}^3 \text{ treatable leachate} \mid \$10}{\mid 1 \text{ m}^3 \text{ leachate}} = \mathbf{\$\ 9{,}000\ year}$$

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Question 2 (continued)

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

(Two points can be earned: 1 point for a discussion of each viable method. Only the first two methods are scored.)

Category of Reduction	Method or Action
Disposal options	• Sort waste stream for cadmium-containing products (batteries, e-waste, paints and pigments, stabilizers, pesticides) headed to landfills • Deposit these materials at a dropoff site or recycling facility, or return to manufacturer
New/substitute technology or alternate materials	Avoid use of cadmium-containing products by: • using rechargeable batteries (e.g., lithium rechargeable) • applying new technology and/or alternate materials that do not use cadmium
Incentives and/or disincentives	• Place restrictions on disposal of materials that contain cadmium (batteries, e-waste, paints and pigments, stabilizers, pesticides) • Pass cradle-to-grave (RCRA) legislation • Provide rebate incentives for using cadmium-free products • Provide incentives for manufacturing cadmium-free products (e.g., research grants) • Place a deposit (payable on return) or surcharge on cadmium-containing products
Education	Make the public aware of (any one of the following): • concerns (health, environmental) associated with cadmium • methods of cadmium-containing product/battery reduction/recycling • availability of new/substitute technology

Question 2 (continued)

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

(One point is earned for an explanation that is linked to an accepted method described in part (d).)

Difficulty and/or expense identified with:

- educating the public about benefits of recycling waste that contains cadmium
- providing efficient systems for cadmium waste pickup (recycling/reuse)
- sorting
- achieving 100 percent cadmium removal from waste or 100 percent replacement
- safe disposal, new technology, and substitute material development
- enforcement/regulations/compliance
- recycling (e.g., energy requirements)
- determining if a product contains cadmium

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Question 3

(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.

(Three points can be earned: 1 point for each correct characteristic, and 1 point for a correct explanation. Only the first two characteristics given are scored.)

Characteristics of Forests
• Accumulation of combustible materials (layer of leaf litter and debris on forest floor, dead trees, etc.) • Increase in understory growth (grasses, shrubs, brush, ladder trees) • Larger trees develop • Even-aged stands develop • Tree density increases • Fire-intolerant species increase in number in the understory • Fire-tolerant species that need fire to germinate seeds decrease in population • Increased canopy coverage eliminates understory growth • Increase or decrease in the rate of nutrient cycling (e.g., release of nutrients of litter, lack of nutrient-rich ash) • No loss of nutrients to burning in intense fires • Increased susceptibility to disease/parasites

Explanations for Increased Fire Risk
Adds to fuel load [intensity] • Increased leaf litter • Increased density of large trees • Increased size of trees • Increase in brush and small trees • Species composition change Adds to spreading of fire [extent] • Increased density of trees • Increased density of understory growth • Ladder trees leading to crown fires

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Question 3 (continued)

(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.

(Two points can be earned: 1 point for a correct positive effect and description; 1 point for a correct negative effect and description.)

Positive Effect and Description	Negative Effect and Description
Increased removal of medium and large trees/small tree brush removal will: • lead to economic growth in the lumber industry Increased removal of medium and large trees will: • allow understory to develop into larger trees, potentially enhancing forest habitat • make additional timber available to use (must indicate usage) • result in thinned trees resistant to pests and disease/impede spread of diseases and pests • enhance economic value of the surrounding areas (housing, lower insurance) • lower the cost of timber • result in a change of aesthetics (with explanation)	The removal of medium and large trees/small tree brush removal will: • reduce available habitat for other organisms in the forest biome • allow timber companies to cut in areas remote from forest communities not threatened by forest fires • cause a reduction in biodiversity (must include a specific example: reduction in nest sites, decrease in seed trees, etc.) • increase soil erosion • increase logging practices (e.g., roads providing access to new areas) • reduce public input • result in a change in aesthetics (with explanation)

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Question 3 (continued)

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

(Four points can be earned: 1 point for each correct ecosystem service, and 1 point for each correct link that describes the impact of clear-cutting. Only the first two characteristics given are scored.)

Ecosystem Service	Impact of Clear-Cutting
Carbon that is removed from the atmosphere by trees helps to limit the magnitude of the atmospheric greenhouse effect.	• Some carbon will be released to the atmosphere or will not be removed
Forests provide oxygen (via photosynthesis).	• Some loss of oxygen, without which we cannot live
Forests provide food products for human consumption (deer, nuts, fungi).	• Can change available browsing places and sighting of animals due to species composition change, increasing their availability for humans (e.g., deer)
Forests provide habitat for many species, some of which provide food and goods for humans, some of which cause harm.	• Loss of habitat (biodiversity)
Forests provide wood (e.g., construction material, paper)	• Increase in the short-term availability of wood, but potential long-term loss of availability
Forests provide wood for fuel.	• Increase in the short-term availability of wood, but potential long-term loss of availability
Many products, such as glue, rubber, and medicines, are produced with forest products.	• Increase in the short-term availability of these products, but potential long-term loss of availability
Forests influence the local microclimate affecting humans (change in temperature, shade, UV, wind breaks).	• Change in the microclimate
Forests have aesthetic value (hiking, camping, photography, tourism, etc.).	• Decreases in natural beauty
Forests improve the quality of soil and water used by humans. (Soil and water must be linked to a specific human use.)	• Increases in erosion and runoff and decreases in groundwater recharge, changing water quality

Question 3 (continued)

Ecosystem Service	Impact of Clear-Cutting
Forests maintain watershed integrity (e.g., flood control with specific human application).	• Decreases in watershed integrity

(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.

(Two points can be earned; 1 point for identification of biome; 1 point for correct explanation of how fire maintains biome.)

Grasslands (savannah, steppe, veldt, pampas, prairie, marquis, garrigue—regional descriptions should include mention of grasslands):

- Fire destroys invasive plant species (e.g., other grasses and trees) that compete for resources with native grasses.
- Fire removes cover and allows sunlight penetration.
- Fire helps the seeds of native grasses to germinate.
- Fires enhance cycling of nutrients back into the soil.

Chaparral (Mediterranean scrubland, Mediterranean shrubland—regional descriptions should include mention of location):

- Fire removes brush, reducing competition for resources.
- Fire helps plants that require fire or lack of brush cover to germinate.
- Species that vigorously stump sprout quickly regenerate themselves.
- Fires enhance cycling of nutrients back into the soil.

Note: Any forest biome earns no credit.

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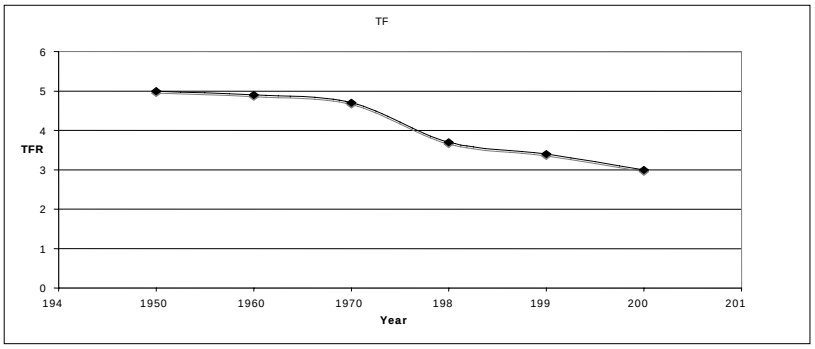
Question 4

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

(Two points can be earned: 1 point for correctly plotting the data [no more than one data point may be misaligned], and 1 point for correctly setting up BOTH axes with a consistent scale interval.)

Notes: Bar graphs are acceptable. Students need not connect the data points. Award no credit for flipped axes.



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

(Three points can be earned: 1 point for each valid cause, and 1 point for discussion of a valid cause—cause and discussion MUST BE LINKED. Two points maximum may be earned for causes; 1 point maximum for discussion. A single discussion point may be earned by itself.)

Cause	Discussion
Increased/improved family planning	• Fewer pregnancies/control of fertility/choice in number of children born
Increased education for women (stay in school longer)/improved social status of women	• Delay having children/choosing to have fewer children
More women enter the workforce	• Delay having children
Reduced need for children in workforce/on farm	• More industrialization/less agriculture/increased urbanization
More industrialization/less agriculture/increased urbanization	• Reduced need for children in workforce/on farm

Question 4 (continued)

Cause	Discussion
Improved health care (lower infant mortality)	• More children will survive to adulthood
People marry later	• Childbearing delayed/fewer children
Changing cultural values	• Socially acceptable to have fewer children
Government policies that restrict number of children allowed per woman	• Countries are facing overpopulation issues
Increased cost of raising children	• Standard of living and education costs have increased
Increased urbanization	• Lessens living space for more children

(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.

(Four points can be earned: 1 point for each correct factor, and 1 point for each correct discussion of the factor. Discussion points may be earned without an identified factor. However, if factors are given, discussion and factors MUST BE LINKED.)

Factors (Societal or Economic)	Discussion
Kenya has a much higher infant mortality rate.	• There is a shortage of prenatal and pediatric care due to poverty in Kenya. • Kenyans have more children to ensure that some survive.
Kenya is more agricultural (second stage of demographic transition).	• In Kenya more children are needed to help farm.
Kenya is a less-developed country (lower per-capita income)/poorer/nonindustrialized.	• Children provide income to the family. • Contraceptives are not affordable.

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Question 4 (continued)

Factors (Societal or Economic)	Discussion
Women in Kenya lack education and job opportunities.	• Women in Kenya have fewer career/work choices so they have children at an earlier age than women in the United States do. • Women in Kenya do not delay childbearing, in contrast with women in the United States who often delay starting a family due to the high cost of childcare.
There is no pension system to support people as they age in Kenya.	• More children are needed to support parents in old age.
There is less education about family planning in Kenya.	• There is less ability to control fertility.
Cultural values favor larger families in Kenya.	• More children mean greater social status.
Women in Kenya have a low social status /marry at an earlier age.	• Women have little or no choice/control of their fertility; they have more years of childbearing.
There is a preference for male children in Kenya.	• People have more children to get as many sons as possible, because sons will continue to support the family.
The cost of raising a child in the United States is much higher than in Kenya.	• People in the United States choose to have smaller families.
Abortion is illegal in Kenya.	• Results in more births.
Religious values in Kenya prohibit contraception/abortion.	• Results in more births.

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Question 4 (continued)

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

(Two points can be earned: 1 point for each accurate description. The student must link a specific activity to a specific impact on biodiversity.)

- Deforestation for the following purpose destroys habitats and reduces biodiversity (may use two activities for 1 point each):
  - farming (i.e., creation of monocultures);
  - housing/development (i.e., urbanization);
  - fuel (wood);
  - fossil-fuel recovery (mining and drilling).
- Fossil-fuel burning releases carbon dioxide resulting in climate change, altering global/regional/local temperature and precipitation patterns leading to reduction of biodiversity within ecosystems where organisms have very specific climatic requirements for survival.
- Pollution (student must identify specific contaminants linked to human activity that have a negative impact on species and biodiversity).
- Intensive fish farming spreads parasites and disease to native species, reducing biodiversity.
- Diversion of freshwater for agricultural, municipal, and industrial use reduces water supply for biodiverse freshwater ecosystems.
- Damming of rivers makes it difficult for species that breed/spawn upstream (e.g., salmon) to reproduce, reducing biodiversity.
- Overfishing leads to small, unsustainable populations of fish species, reducing biodiversity.
- Building landfills for increased amounts of trash destroys habitat, reducing biodiversity.
- Poaching of wild animals (e.g., bush meat) due to increased human population and demand for food leads to dwindling populations that may not be sustainable.
- Using genetically modified crops to increase yield of food crops can negatively impact other species (e.g., monarch butterfly larvae can be killed when they ingest toxin-containing genetically modified corn pollen that has settled on milkweed leaves near genetically modified corn fields).