AP® Environmental Science
2011 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 following article from the *Fremont Inquirer* and answer the questions that follow.

Fremont Inquirer **May 1, 2010**

BEETLES BOOM BUT BEES BUST

We share our world with millions of insect species that we tend to overlook in our daily lives. Yet once in a while, some insect species do make the front page — sometimes because their populations are exploding and other times because they seem to be performing a disappearing act. Examples of such species are the mountain pine beetle and the European honeybee.

In the western United States, outbreaks of forest destruction caused by mountain pine beetles have been recorded since the late 1880s. But in the past few decades, mountain pine beetles have been killing mature trees (preferred targets of the beetles) at accelerated rates, and now millions of acres of pine forests have been affected. Fire-suppression policies, the practice of clear-cutting, and lowered winter mortality of beetle larvae have all been implicated in causing the epidemic proportions of the beetles' forest-destroying activities.

While mountain pine beetle populations are booming, European honeybees are in trouble. Many valuable food crops are dependent on pollination by honeybees, yet the number of managed honeybee colonies has dropped significantly since the 1970s due to colony collapse disorder (CCD), which is characterized by the sudden disappearance of all the worker bees in a colony. Recent scientific research suggests that many stress factors of anthropogenic origin are the culprits in CCD. Some farmers are trying to use fewer colonies to pollinate their crops, some are hoping that other natural pollinators (e.g., native wild bees, other insects, bats) will do the job of pollination for them.

(a) As mentioned in the article, there are several possible explanations for the increase in mountain pine beetles.

(i) Provide one reason why fire-suppression policies lead to increased beetle activity.

(ii) Reduced winter mortality of beetle larvae is likely a consequence of global climate change. Describe TWO ways that the activities of the beetles might enhance climate change.

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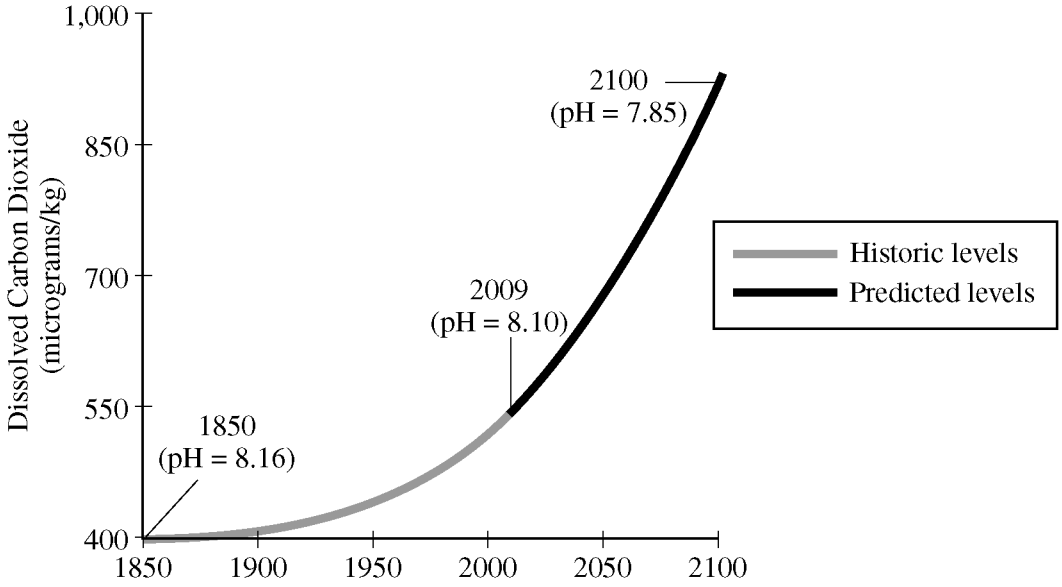
(b) The widespread death of trees leads to a series of changes in a forest ecosystem. Identify TWO physical changes that occur in the forest ecosystem as the result of the death of mature trees. For each physical change you identify, describe an impact of that change on the forest ecosystem.

(c) As the article states, the number of managed honeybee colonies has dropped significantly over the past few decades. Describe TWO specific economic consequences of the collapse of the managed honeybee colonies.

(d) Pollination by native insects is considered an ecosystem service. Identify a different ecosystem service and explain how that service benefits human society.



2. Coral reefs are produced when corals acquire calcium ions (Ca^{2+}) and carbonate ions (CO_3^{2-}) from seawater and deposit solid $CaCO_3$ to form their exoskeletons. Scientists are concerned that relatively rapid decreases in ocean water pH will hinder the deposition of $CaCO_3$. The graph above shows the amount of CO_2 dissolved in ocean water and ocean water pH (shown in parentheses) since 1850 and the predicted changes through 2100.

(a) Explain how an increase in the amount of dissolved CO_2 in ocean water results in a decrease in the pH of ocean water.

(b) Explain why the movement of carbon into the ocean has been increasing since 1850.

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(c) In order to model the effects of ocean acidification on coral reefs, some simplifying assumptions can be made. Use the assumptions in the table below to perform the calculations that follow.

Assume that the total global area of corals growing in reefs is 2.5×10^{11} m^2.
Assume that corals grow only vertically and that the average vertical growth rate of corals is 3 mm/year.
Assume that the average density of $CaCO_3$ in corals is 2×10^3 kg/m^3.

(i) Calculate the current annual global increase in volume, in m^3, of $CaCO_3$ in coral reefs. Show all steps in your calculation.

(ii) Calculate the current annual global increase in mass, in kg, of $CaCO_3$ in coral reefs. Show all steps in your calculation.

(iii) Because of ocean acidification, it is expected that in 2050 the mass of $CaCO_3$ deposited annually in coral reefs will be 20 percent less than is deposited currently. Calculate how much less $CaCO_3$, in kg, is expected to be deposited in 2050 than would be deposited if ocean water pH were to remain at its current value.

(d) Identify and describe one likely negative environmental impact of the loss of coral reefs.

(e) Identify one environmental problem (other than one due to ocean acidification or loss of coral reefs) that affects marine ecosystems on a global scale.

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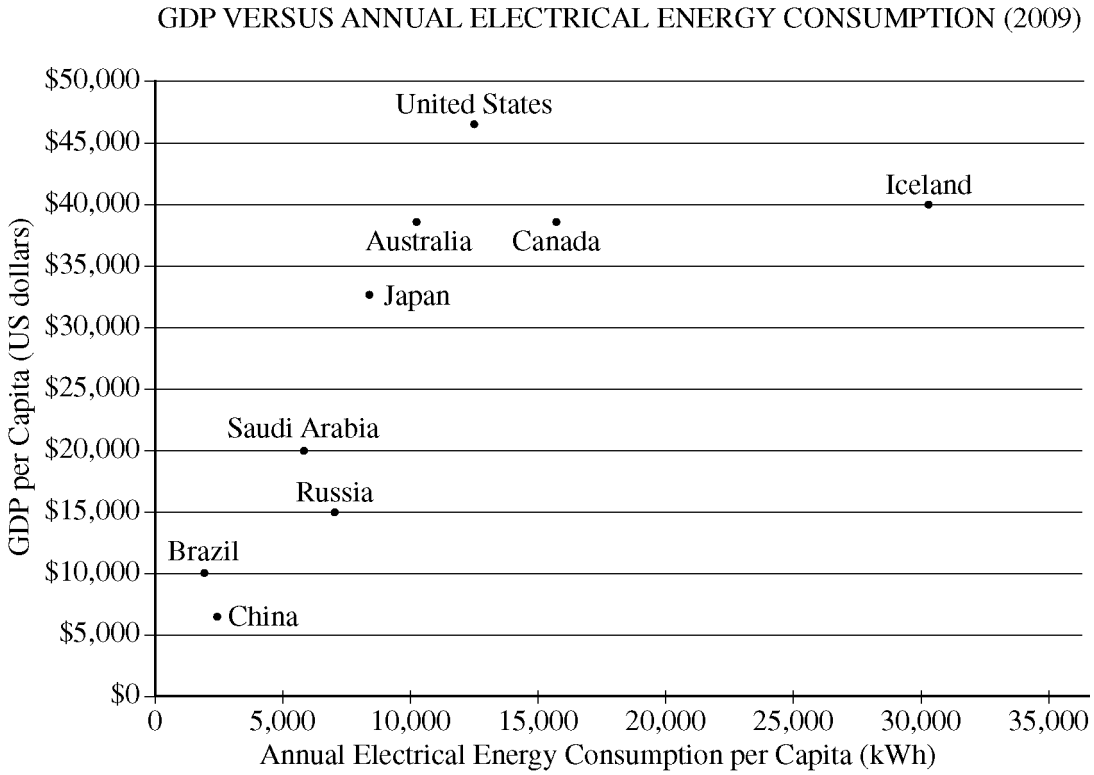

3. Shown above is a graph of the gross domestic product (GDP) per capita versus the annual electrical energy consumption per capita for nine countries in 2009.

   (a) Iceland's position on the graph is due in part to its access to geothermal energy sources. Describe how electricity is generated from a geothermal source.

   (b) Despite its low GDP per capita and low annual electrical energy consumption per capita, China has become the world's largest emitter of CO_2. Explain this apparent contradiction.

   (c) In addition to contributing to increased atmospheric CO_2 concentrations, China is facing other air pollution issues related to the generation of electricity. Identify one such issue and describe the impact it has on human health.

   (d) Two countries shown on the graph have developed domestic energy sources: sugarcane in Brazil and tar sands in western Canada.

      (i) Choose EITHER sugarcane or tar sands, then briefly describe the process of fuel production from that energy source.

      (ii) Describe TWO disadvantages of using the energy source that you chose in part (d)(i).

      (iii) Which of the two energy sources is more sustainable? Justify your answer with an explanation.

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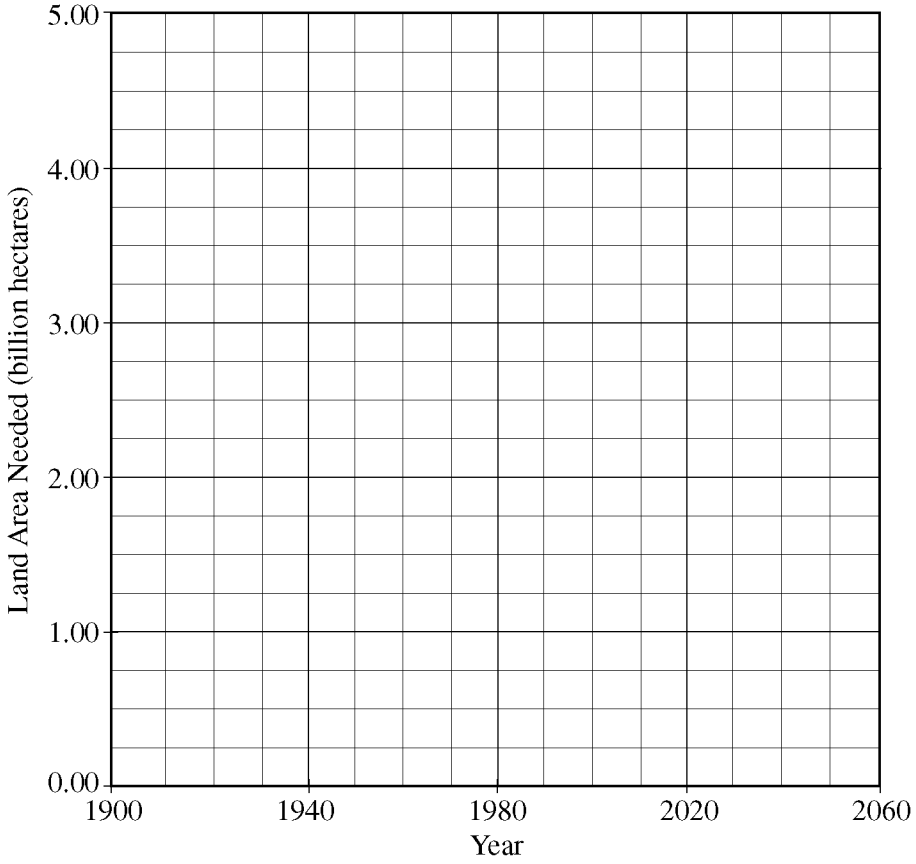
4. As the world's population increases and availability of new arable land decreases, providing sufficient food for the world's human population is becoming increasingly difficult. The table below shows the area of land needed to feed the world's population from 1900 projected to the year 2060.

Year	1900	1940	1980	2020	2060
Land Area Needed (billion hectares)	0.40	0.60	1.25	2.50	4.75

(a) On the graph below, plot the data from the table above and draw a smooth curve.



(b) Assume that the maximum arable land area on Earth is 4.00 billion hectares. Using the smooth curve that you created above, determine the year in which the human population is likely to run out of arable land for agriculture.

(c) Soil quality is a critical factor in agriculture. Identify TWO physical and/or chemical properties of soils and describe the role of each property in determining soil quality.

(d) Describe TWO viable strategies for reducing the amount of land needed for agriculture.

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(e) One problem that can result from agriculture is soil salinization.

(i) Describe how salinization occurs.

(ii) Describe one method to prevent or remediate soil salinization.

STOP

END OF EXAM

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