ENVIRONMENTAL SCIENCE

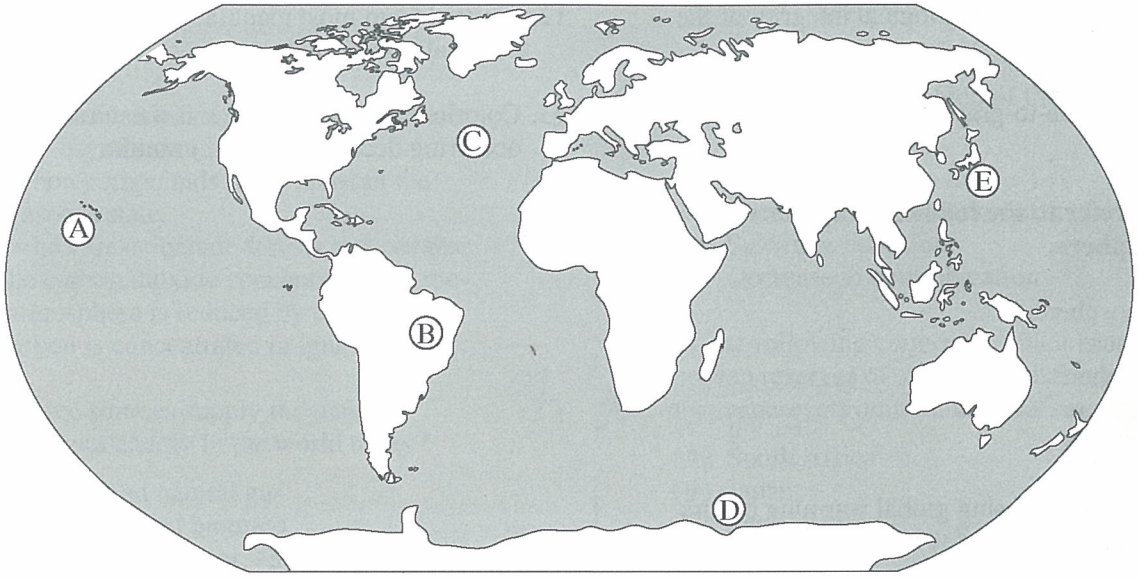
Section I

Time—1 hour and 30 minutes

Part A

Directions: Each set of lettered choices below refers to the numbered questions or statements immediately following it. Select the one lettered choice that best answers each question or best fits each statement and then fill in the corresponding oval on the answer sheet. A choice may be used once, more than once, or not at all in each set.

Questions 1-3 refer to the locations marked by letters on the world map below.



1. The location where new crust is being created at a divergent plate boundary

2. The location where one tectonic plate is being forced beneath another, creating a volcanic arc.

3. The intraplate location where hot-spot volcanism is occurring

Unauthorized copying or reuse of any part of this page is illegal.

Questions 4-6 refer to the following.

(A) Safe Drinking Water Act
(B) Clean Water Act
(C) Comprehensive Environmental Response Compensation and Liability Act (CERCLA)
(D) Resource Conservation and Recovery Act
(E) Toxic Substances Control Act

4. Requires minimum safety standards for community water supplies

5. Mandates the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters

6. Establishes cradle-to-grave tracking of hazardous waste

Questions 7-9 refer to the following regions of Earth's atmosphere.

(A) Thermosphere
(B) Exosphere
(C) Troposphere
(D) Mesosphere
(E) Stratosphere

7. The phenomenon causing global warming occurs primarily in this region of the atmosphere.

8. The beneficial ozone layer is in this region of the atmosphere.

9. Most oxygen is found in this layer of the atmosphere.

Questions 10-13 refer to the substances listed.

(A) Asbestos
(B) Radon
(C) Lead
(D) Carbon monoxide
(E) Formaldehyde

10. Found in old plumbing pipes and fixtures and some ceramic glazes

11. Composed of fibers known to cause lung disease

12. Emitted from most manufactured building materials and furniture

13. Colorless, odorless gas that is a naturally occurring decay product of uranium

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

Part B

Directions: Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and then fill in the corresponding oval on the answer sheet.

14. The greatest amount of fresh water is found in which of the following?
    (A) The atmosphere
    (B) Estuaries
    (C) Lakes
    (D) Rivers and streams
    (E) Polar ice caps and glaciers

15. Which of the following is true of carbon as it cycles in nature?
    (A) Carbon dioxide is released during photosynthesis.
    (B) Carbon compounds rarely exist in the gaseous state.
    (C) Carbon sinks include forests and oceans.
    (D) The carbon dioxide concentration in the atmosphere is reduced by cutting trees.
    (E) Carbon is concentrated in igneous rocks.

16. Which three sources supply the majority of commercial energy in the world today?
    (A) Coal, oil, and natural gas
    (B) Solar, wind, and biomass
    (C) Nuclear, hydropower, and photovoltaics
    (D) Wood, dung, and charcoal
    (E) Fuel cells, geothermal, and tidal power

17. By the year 2050, world population is expected to approach 10 billion. If the current population trends continue, which region of the world will most likely experience the majority of the growth?
    (A) North and Central America
    (B) Central and South America
    (C) Eastern and Western Europe
    (D) Africa and Asia
    (E) Australia and New Zealand

18. Which of the following human activities is most closely associated with depletion of the stratospheric ozone layer?
    (A) Mining of coal
    (B) Disposal of refrigerators and air conditioners
    (C) Heating of homes and factories
    (D) Generation of electricity
    (E) Agricultural irrigation

19. Overuse of groundwater in coastal areas would most likely result in which of the following?
    (A) Rise in water table
    (B) Increase in stream flow
    (C) Bacterial contamination of surface water
    (D) Saltwater intrusion
    (E) Decrease in eutrophication

20. Of the following countries, which has the largest proven reserves of strategic metals such as manganese, chromium, and platinum?
    (A) South Africa
    (B) Japan
    (C) Saudi Arabia
    (D) The United States
    (E) France

21. In 2007 in the United States there were approximately 480 cars for every 1,000 people. The total number of cars in the United States in 2007 was closest to
    (A) 150,000
    (B) 30,000,000
    (C) 150,000,000
    (D) 300,000,000
    (E) 3,000,000,000

Unauthorized copying or reuse of any part of this page is illegal.

22. Which of the following world regions contain the greatest area of rain forest?
(A) Canada and the United States
(B) Eastern and Western Europe
(C) Russia and China
(D) Australia and New Zealand
(E) Brazil and Indonesia

23. Which of the following best exemplifies population momentum?
(A) Continued growth of a population after fertility drops to replacement level
(B) Continued growth of a population due to emigration
(C) Decreased population due to increase in the death rate
(D) Decreased population due to a reduced death rate and an increased fertility rate
(E) Growth of a population after the fertility rate doubles

24. Of the following strategies to decrease the landfill volume of packaging material from food and other consumer products, the most energy efficient is
(A) recovering plastic packaging material from the waste stream and recycling it
(B) recovering metal packaging material from the waste stream and recycling it
(C) limiting the size of individual beverage containers made from metal, glass, or plastic
(D) using more packaging materials that are manufactured from raw materials that are renewable
(E) promoting the use of reusable containers for consumer goods

25. An integrated pest-management approach to pest control emphasizes which of the following?
(A) Eradication of the pest population
(B) Reliance on spraying broad-spectrum pesticides
(C) Reduction of crop damage to an economically tolerable level
(D) Use of plant monocultures to simplify spraying
(E) Elimination of the use of second-generation pesticides

26. Of the following, which is true of noise pollution?
(A) Noise pollution is an insignificant occupational hazard.
(B) Noise at 100 decibels has twice the energy of noise at 50 decibels.
(C) Hearing damage occurs most quickly when the intensity level of the sound is low.
(D) In urban areas, few individuals are exposed to noise pollution.
(E) Sudden or persistent noise may lead to permanent hearing loss.

27. If a country has a crude birth rate of 24 per 1,000 and a crude death rate of 8 per 1,000, the natural annual percent increase of its population is
(A) 0.6%
(B) 1.6%
(C) 3%
(D) 16%
(E) 32%

28. Which of the following shows the approximate concentration of CO_2, N_2, and O_2 in dry air?

	CO_2	N_2	O_2
(A)	78%	< 1%	21%
(B)	43%	< 1%	56%
(C)	36%	8%	56%
(D)	10%	70%	20%
(E)	< 1%	78%	21%

29. Which of the following best illustrates an abiotic component of the environment affecting a biotic component of the environment?
(A) Composted manure is added to agricultural soil during spring tilling.
(B) Coral reefs modify the direction of an ocean current.
(C) Plants release O_2 into the atmosphere during photosynthesis.
(D) Low phosphorus content in soil limits the growth of vegetation.
(E) A thick planting of ground cover reduces soil erosion on a hillside.

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

30. Of the following cities, which regularly experiences the worst levels of photochemical smog that is enhanced by thermal inversions?
(A) New York City, New York
(B) Los Angeles, California
(C) Portland, Oregon
(D) Atlanta, Georgia
(E) Philadelphia, Pennsylvania

31. Which of the following best describes the first law of thermodynamics?
(A) Energy always changes from a more useful, more concentrated form to a less useful, less concentrated form.
(B) In a closed system of constant mass, the energy involved in any physical or chemical change is neither created nor destroyed, but merely changed from one form to another.
(C) Heat always flows from a hot body to a cold body.
(D) Entropy of a system increases as the state of disorganization in the system increases.
(E) In a reversible process, the entropy of the system is constant, whereas in an irreversible process, the entropy of the system increases.

32. What two main factors would best indicate the quality of life of a country's population?
(A) The total fertility rate and the death rate
(B) The crude birth rate and crude death rate
(C) The birth rate and the infant mortality rate
(D) The replacement-level fertility rate and the total fertility rate
(E) The life expectancy and the infant mortality rate

33. Rachel Carson's contributions to the environmental movement include which of the following?
(A) Alerting the public to the hazardous waste problem at Love Canal
(B) Increasing public awareness of the risks of using pesticides
(C) Starting the first Earth Day in 1970
(D) Discovering the thinning of the ozone layer in polar regions
(E) Being the first female administrator of the EPA

34. In a typical forest ecosystem, dead trees and fallen trees are most important because of their role in which of the following?
(A) Providing a valuable source of timber
(B) Providing habitats for wildlife
(C) Contributing to soil erosion
(D) Increasing water runoff
(E) Removing carbon dioxide from the air

35. Possible effects of a warmer atmosphere include which of the following?
I. Expanded ranges of tropical diseases
II. More intense hurricanes and typhoons
III. Increased crop damage from pests and diseases
(A) I only
(B) II only
(C) I and III only
(D) II and III only
(E) I, II, and III

36. When a rain forest is slashed and burned, the local concentration of carbon dioxide in the atmosphere increases. This is primarily due to
(A) changes in the local climate
(B) oxidation of carbon compounds
(C) cellular respiration of rain-forest plants
(D) erosion of exposed soil
(E) carbon dioxide being released by anaerobic organisms

37. Pollution is considered an external cost when
(A) it has harmful effects borne only by the people who purchase the products that cause the pollution
(B) the cost to the environment is not reflected in the price of the products that produce the pollution
(C) it has a significant impact on the consumer's decision to buy a product that pollutes
(D) it is a hidden cost that would result in a greater demand for the product if the consumer were aware of the hidden cost
(E) it is produced in the external environment by a malfunction in the operation of the product

Unauthorized copying or reuse of any part of this page is illegal.

38. A sustainable society would emphasize

(A) maintaining the current rates of energy flow and resource use
(B) converting the world's high-quality energy resources to low-quality heat
(C) recycling both matter and high-quality energy
(D) using energy efficiently and reusing and recycling matter
(E) quickly expanding nuclear power, because it is a renewable resource

39. A large forested area is fragmented into small forest tracts separated by agricultural areas. This change will most likely lead to

(A) an increase in the population of top carnivores
(B) an improvement in the dispersal mechanisms of forest species
(C) a more stable regional climate
(D) a decrease in the amount of edge habitat
(E) a decrease in the gene flow within species of the original forest

40. Which of the following is a greenhouse gas that is produced by domestic livestock?

(A) NO_2
(B) CH_4
(C) O_3
(D) CO
(E) SO_2

Questions 41-42

In 1997 the World Resources Institute estimated the world's proven oil reserves to be 1,000 billion barrels and the ultimately recoverable reserves to be 2,000 billion barrels. The table below shows the world consumption of oil from 1986 to 1997.

Year	Consumption (million barrels per day)
1986	62
1987	63
1988	65
1989	66
1990	66
1991	67
1992	67
1993	67
1994	68
1995	70
1996	72
1997	74

41. At the 1997 rate of consumption, ~~about~~ how long will the estimated 2,000 billion barrels of oil last?

(A) 25 years
(B) 50 years
(C) 75 years
(D) 200 years
(E) 500 years

42. What was the approximate percent increase in consumption from 1986 to 1997 ?

(A) 10%
(B) 20%
(C) 30%
(D) 50%
(E) 80%

Unauthorized copying or reuse of any part of this page is illegal.

43. Which of the following is most typically associated with the transition from a rural to an urbanized society?

(A) Reduced birth rates
(B) Reduced need for sewage-treatment facilities
(C) Increased rates of population growth
(D) Increased air quality in urban areas
(E) Increased stabilization of microclimate in urban areas

44. Five islands, *A*, *B*, *C*, *D*, and *E*, differ only in distance from the mainland, area, and species diversity. Which island would be predicted to have the highest species diversity?

Island	Distance from Mainland (kilometers)	Area (hectares)
(A) *A*	50	1×10^2
(B) *B*	50	1×10^6
(C) *C*	500	1×10^2
(D) *D*	1,000	1×10^2
(E) *E*	1,000	1×10^6

45. Which of the following best illustrates point-source pollution?

(A) Toxic sediments in the delta of a major river
(B) Increase in NO_x in a traffic-clogged city
(C) Dust blowing off unpaved roads
(D) Smoke emitted from forest fires
(E) Smokestack emissions from a large smelting company

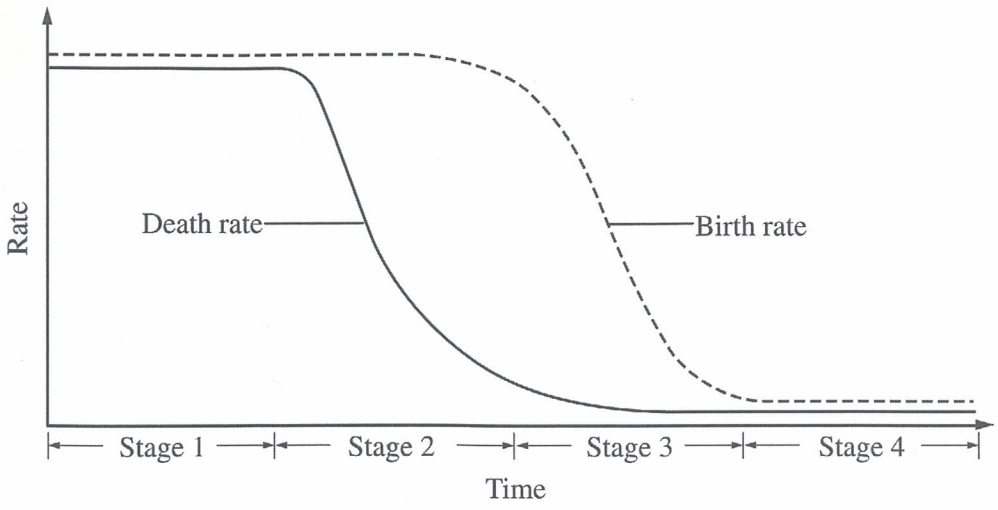
46. The net annual primary productivity of a particular wetland ecosystem is found to be 8,000 kcal/m^2 per year. If respiration by the aquatic producers is 12,000 kcal/m^2 per year, what is the gross annual primary productivity for this ecosystem, in kcal/m^2 per year?

(A) 4,000
(B) 8,000
(C) 12,000
(D) 20,000
(E) 96,000

47. The three main anthropogenic sources of gaseous air pollutants in the United States are

(A) soil erosion, volcanoes, and forest fires
(B) soil erosion, volcanoes, and energy production
(C) industry, construction, and agriculture
(D) industry, transportation, and energy production
(E) industry, transportation, and agriculture

Unauthorized copying or reuse of any part of this page is illegal.



48. During which stage of the demographic transition shown above does a population begin to experience an explosive increase in growth?

(A) Stage 1
(B) Stage 2
(C) Stage 3
(D) Stage 4
(E) After stage 4

---

49. Most municipal solid waste in the United States is disposed of in

(A) the oceans
(B) sanitary landfills
(C) deep wells
(D) open dumps
(E) abandoned mines

50. Which of the following would likely reduce the threats posed by exotic species to native species?

I. Increasing inspections of goods coming into a country
II. Mandating that bilgewater from vessels be emptied in ports instead of in the open ocean
III. Enforcing legislation that restricts imported materials such as untreated wooden packing crates

(A) I only
(B) II only
(C) III only
(D) I and III only
(E) I, II, and III

51. Which of the following is a measure of the amount of suspended material in water?

(A) Salinity
(B) Turbidity
(C) Trace-metal concentration
(D) Leachate concentration
(E) pH

52. Acid deposition would most likely result in which of the following?

(A) The release of aluminum ions from soil
(B) An increase in populations of mollusks
(C) The death of species tolerant of low pH levels
(D) An increase in buffering of lake water by sulfates
(E) An increase in the pH of unbuffered water

53. Which of the following are the three major sources of nutrients and calories for the global human population?

(A) Potatoes, fish, and barley
(B) Wheat, beef, and potatoes
(C) Oats, soybeans, and poultry
(D) Corn (maize), wheat, and rice
(E) Rye, beef, and eggs

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

54. If Earth had no atmosphere, the mean surface temperature would be approximately −15°C. With our present atmosphere, Earth's mean surface temperature is approximately +15°C. Which of the following is the best explanation for this difference?

(A) Reflection of incident solar radiation by clouds
(B) Scattering of visible radiation by aerosols
(C) Absorption of ultraviolet radiation by the ozone layer
(D) Absorption of infrared radiation by atmospheric gases
(E) The breakdown of oxygen molecules in the thermosphere

55. Which of the following can be used to assess the biological diversity of an area?

(A) Population size of each species and area occupied by each population
(B) Minimum population area and minimum viable population size
(C) Ratio of *r*-strategists to *K*-strategists and life expectancy of *K*-strategists
(D) Number of individuals under fifteen years old and number of individuals over sixty-five years old
(E) Genetic variation within each species and number of species present

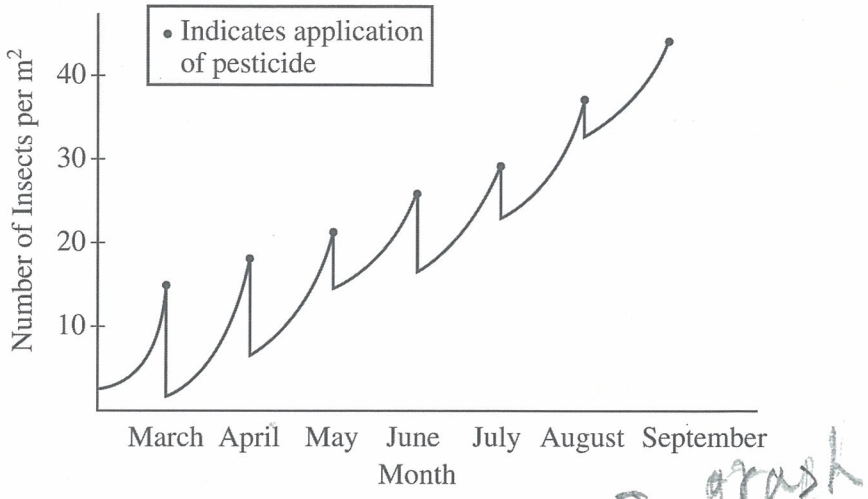
56. Which of the following is a way for the government to encourage efficient energy use?

(A) Requiring higher fuel economy standards for new cars
(B) Implementing government subsidies to keep gasoline prices low
(C) Raising the speed limit from 55 to 70 miles per hour
(D) Limiting the development of public transportation systems
(E) Removing all taxes from gasoline at the fuel pump

57. Ground-level ozone in most major United States cities results primarily from

(A) burning coal
(B) burning fuel for cooking
(C) producing electric power
(D) industrial emissions
(E) motor-vehicle exhaust

Unauthorized copying or reuse of any part of this page is illegal.



58. An insect population in an agricultural field is affected by monthly applications of a pesticide, as shown in the graph above. A likely cause of the overall increase in the insect population over time is

(A) an increase in the population of insect predators
(B) an increase in average temperature over the summer
(C) an increase in soil salinity
(D) a decrease in the moisture content of the soil
(E) the survival of increasing numbers of resistant insects

---

59. The process in the hydrologic cycle in which water vapor is released from leaves into the atmosphere is called

(A) infiltration
(B) transpiration
(C) sublimation
(D) reflection
(E) percolation

60. Which of the following terms applies to the economic approach of including external costs in the price of goods and services?

(A) Optimal-cost pricing
(B) Cost-benefit pricing
(C) Full-cost pricing
(D) Green pricing
(E) Subsidized pricing

61. Global warming is most likely to directly cause which of the following?

(A) Shifting of grain belts toward the equator
(B) Falling sea levels in the Southern Hemisphere
(C) Coastal flooding and submersion of low-lying areas
(D) A decrease in the amount of water vapor in the atmosphere
(E) An increase in the number and size of glaciers

62. Which of the following would encourage recycling?

(A) Decreasing government purchases of recycled materials
(B) Decreasing subsidies for recycling
(C) Decreasing taxes on resource-extracting industries
(D) Decreasing taxes on recycled material
(E) Decreasing fees for using landfills

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE

63. Which of the following is a true statement about passive solar heating?

(A) It is effective only during the summer months.
(B) It is based in part on the principle of the greenhouse effect.
(C) It is not used to heat commercial buildings.
(D) It is not efficient because it cannot produce high-quality energy.
(E) It produces more pollution than heating with an electric heat pump.

64. Which of the following is a common characteristic of lakes undergoing cultural eutrophication?

(A) Decreased rates of sediment accumulation
(B) Decreased amounts of green and blue-green algae
(C) Increased levels of oxygen throughout the water column
(D) Increased water clarity in the epilimnion
(E) Increased levels of plant nutrients

65. An advantage of using natural gas, rather than oil, as a fuel is that natural gas is

(A) less of a contributor to global warming because it does not release CO_2 when it burns
(B) less expensive because most reserves are in the United States
(C) more abundant because it is a by-product of photosynthesis
(D) cleaner because it burns more completely
(E) safer to store because it is a gas

66. Which of the following best explains why the maximum sustainable yield for ocean fisheries has been exceeded?

(A) Populations of fish-eating birds such as the albatross have increased.
(B) Too many fish of reproductive age are harvested.
(C) Too many marine fish farms have been created.
(D) Everything trapped by large bottom trawl nets is used for food.
(E) For every calorie of fish caught, a ship uses only about 0.5 calorie of fuel energy.

67. Although the fertility rate for women in the United States has declined in recent years to a value below replacement level, the United States population is still increasing because of

(A) lower average age at first marriage
(B) lower infant death rates
(C) increased longevity
(D) improved health care
(E) immigration

Item 68 was not scored.

69. Which of the following is an important contributor to both global warming and ozone depletion?

(A) An increase in the concentration of carbon dioxide to higher-than-preindustrial levels
(B) A buildup of methane in the stratosphere to higher-than-preindustrial levels
(C) An increase in the levels of ultraviolet radiation reaching Earth's surface
(D) An increase in the amount of infrared solar radiation absorbed in the troposphere
(E) A release of chlorofluorocarbons to the atmosphere

70. The most populous countries in the world are China, India, and

(A) Indonesia
(B) Russia
(C) the United States
(D) Japan
(E) Mexico

Unauthorized copying or reuse of any part of this page is illegal.

71. Lakes that are characterized by high water clarity and low concentrations of dissolved nutrients are classified as

(A) buffered
(B) climax
(C) eutrophic
(D) oligotrophic
(E) stratified

72. Smoke from forest fires is most likely to affect air quality over larger areas for many days when

(A) smog is produced due to chemical reactions in the atmosphere
(B) a persistent atmospheric inversion exists in the region
(C) oak trees are burned, releasing terpenes into the atmosphere
(D) primary, rather than secondary, forests are burned
(E) vegetation in the region is green and burns more slowly

73. In the majority of less developed countries, the major source of energy for domestic use is which of the following?

(A) Oil
(B) Coal
(C) Biomass
(D) Nuclear
(E) Geothermal

74. When logging is carried out in a watershed, a likely effect on the local streams is

(A) mitigation of anoxia
(B) decreased nutrient levels
(C) decreased input of sediments
(D) increased oligotrophic conditions
(E) increased water temperature

75. When scientists discover the existence of an emerging infectious disease such as SARS (severe acute respiratory syndrome), they must take immediate steps to determine the cause of the disease and the method of transmission. These initial steps would include which of the following?

(A) Developing a vaccine to eliminate the disease
(B) Beginning a program to eradicate insect vectors for the disease
(C) Acquiring recent medical and travel histories of the disease victims
(D) Testing methods to block airborne transmission of the disease
(E) Estimating the cost of eradicating the disease

76. In a river ecosystem, dissolved oxygen concentrations drop quickly downstream from a point-source input of organic matter into the river. This effect is due to

(A) increasing populations of mayfly and stonefly larvae
(B) increasing activity of trout and black bass
(C) increasing bacterial activity as organic matter decays
(D) decreasing bacterial activity as turbidity increases
(E) decreasing water temperature as surface evaporation increases

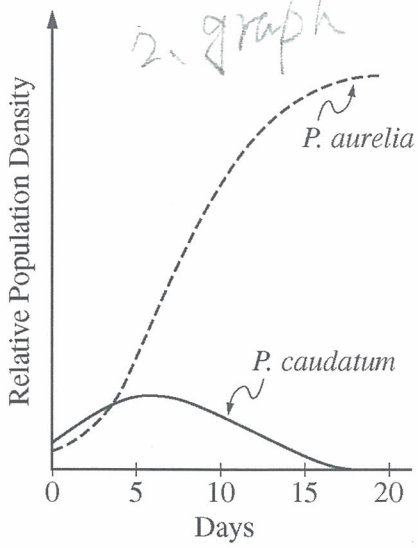
77. What is the population doubling time in years for a country with an annual growth rate of 3.5 percent?

(A) 0.5
(B) 3.5
(C) 20
(D) 24.5
(E) 70

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

78. The graph below shows the results obtained when two species of *Paramecium* were grown together in the same medium.



The graph above best exemplifies

(A) the demographic transition
(B) sustained logarithmic growth
(C) the edge effect
(D) competitive exclusion
(E) the normal distribution

79. In a cost-benefit analysis of the risks associated with an environmental hazard involving human health and safety, which of the following concerns is NOT typically taken into account?

(A) Lower worker productivity resulting from health-related time lost on the job
(B) Higher production costs resulting from the installation of expensive pollution-control devices
(C) The long-term value and peace of mind to society resulting from a cleaner, healthier environment
(D) The initial capital investment required to purchase pollution-control devices
(E) The need to remove pollutants from factory effluents

80. Three common methods employed in the cleanup of oil spills are

(A) aeration of water, skimmer boats, and genetically engineered bacteria
(B) aeration of water, phytoremediation, and genetically engineered bacteria
(C) skimmer boats, high temperature incineration, and phytoremediation
(D) large floating booms, high temperature incineration, and phytoremediation
(E) large floating booms, skimmer boats, and genetically engineered bacteria

81. Ticks are vectors for various diseases. The ticks acquire the disease-causing organisms from

(A) polluted water
(B) feeding on host animals
(C) contact with other ticks
(D) trees and plants in a forest
(E) gene changes as they go through metamorphosis

82. Which of the following is most likely to increase both the nutrient levels and the bacterial content of lake water?

(A) Runoff from a nearby hog farm
(B) Thermal pollution from a nearby power plant
(C) Increased aeration of the lake water
(D) Percolation of the water through soil to groundwater
(E) Acidification of the lake water by acid deposition

83. Which of the following is a major goal of the program begun in 1995 to reintroduce the gray wolf into Yellowstone National Park?

(A) Decrease the number of grizzly bears, because they were becoming a nuisance
(B) Enable the removal of the gray wolf from the endangered species list
(C) Increase the dwindling numbers of tourists that visit the park each year
(D) Upset the natural predator-prey balance between coyotes and elk
(E) Decrease the number of sheep and cattle that wander into the park and overgraze the vegetation

Unauthorized copying or reuse of any part of this page is illegal.

84. The half-life of radon gas is approximately four days. Four weeks after the introduction of radon into a sealed room, the fraction of the original amount remaining is closest to

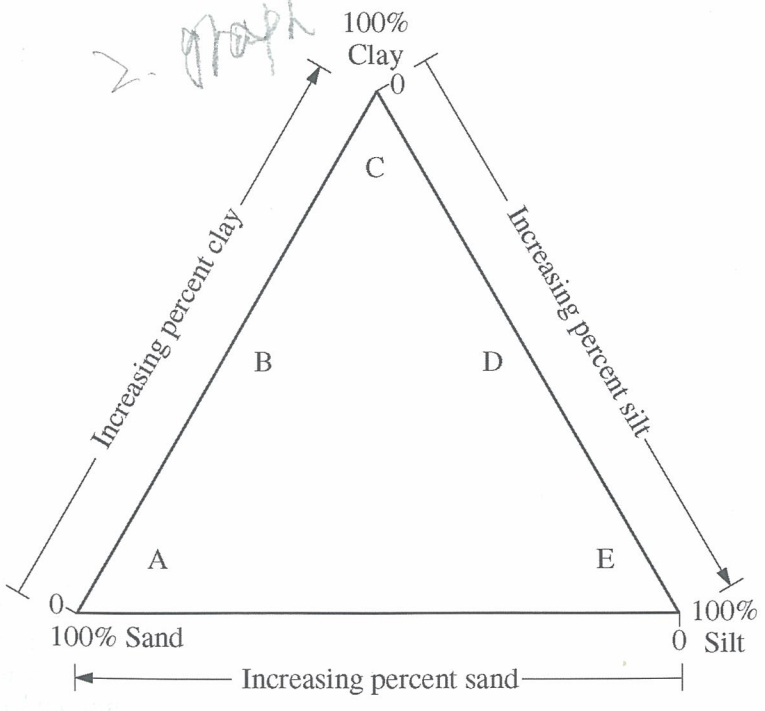
(A) 1/2
(B) 1/8
(C) 1/32
(D) 1/64
(E) 1/128

85. The consumption of mosquitoes by bats and the control of flooding provided by tropical forests in mountainous areas of Central America are examples of

(A) adaptive radiation
(B) ecosystem services
(C) evolution by natural selection
(D) ecological equilibrium
(E) positive feedback loops

86. Which of the following best explains why it is predicted that ozone depletion over the poles will be at its worst between 2010 and 2019 ?

(A) Projected global warming from carbon dioxide emissions is expected to reach a peak during those years.
(B) Ozone-depleting chemicals produced before their use was banned will take that long to reach peak concentrations in the stratosphere.
(C) Deforestation in tropical regions is expected to reach a peak during the second decade of the twenty-first century.
(D) Increased global population will lead to an increase in per capita CO_2 production.
(E) Acid deposition will continue to increase, reaching a peak in approximately 2015.



87. Which soil indicated on the soil triangle above would most likely have the highest water-holding capacity?

(A) Soil A
(B) Soil B
(C) Soil C
(D) Soil D
(E) Soil E

Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

88. Which of the following is a true statement concerning the production of electricity in conventional nuclear power plants using fission reactors?

(A) New nuclear power plants will be built without containment structures, due to the increased insulation in the reactor core.
(B) Thermal energy is converted into mechanical energy and then to electrical energy, as in coal-burning power plants.
(C) Regularly scheduled releases of radioactive gases during production are well below the maximum contamination levels set by the EPA (Environmental Protection Agency).
(D) Nuclear production of electricity is much less expensive per kilowatt-hour than production of electricity at a coal-burning or natural-gas-fueled power plant.
(E) Storage of nuclear waste is no longer an issue, because power plants are now storing all wastes on-site in specialized containment units.

89. Alligators in a Florida lake polluted by high levels of dioxins (chlorinated hydrocarbons) had low testosterone levels and failed to reproduce. Scientists came to the conclusion that the dioxins were acting as which of the following?

(A) Endocrine disrupters
(B) Growth hormones
(C) Carcinogens
(D) Immune-system suppressors
(E) Mutagens

90. Factors that affect the total fertility rate of a human population include which of the following?

I. Cultural traditions
II. Government policies and economic incentives
III. Education level and economic opportunities for females

(A) I only
(B) II only
(C) I and II only
(D) II and III only
(E) I, II, and III

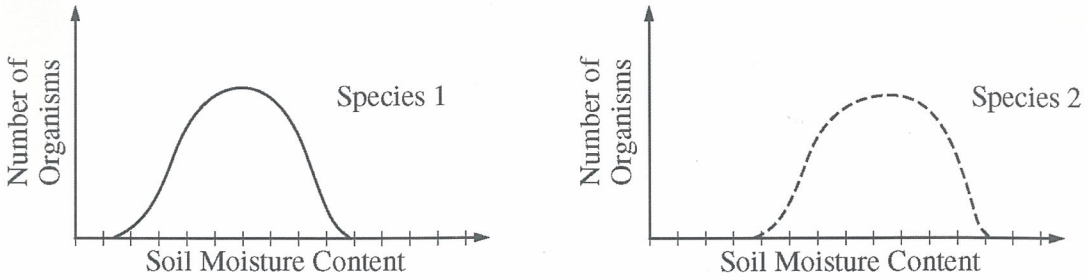
91. Sustainable use of forests in the United States would likely be encouraged by

(A) cutting small groups of medium- and large-sized trees in uneven-aged forests
(B) clear-cutting old-growth forests to allow for secondary succession
(C) allowing road building in wilderness areas so that older, clear-cut forests have time to regenerate
(D) logging on steep slopes in designated wilderness areas
(E) enforcing all provisions of the Resource Conservation and Recovery Act (RCRA)

92. The use of which of the following to control agricultural insect pests is most likely to have a negative and persistent impact on an ecosystem?

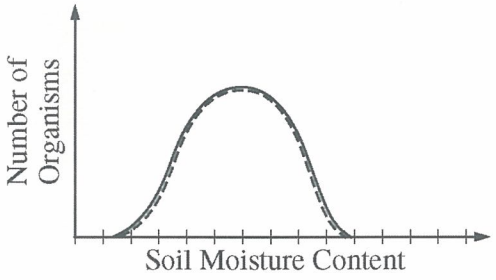
(A) *Bacillus thuringiensis*, a soil organism that kills insect larvae
(B) *Braconid sp.*, a parasitic wasp
(C) Insecticidal soap, a surfactant that kills through suffocation
(D) Lindane, a chlorinated hydrocarbon
(E) Rotenone, a toxic plant derivative

Unauthorized copying or reuse of any part of this page is illegal.

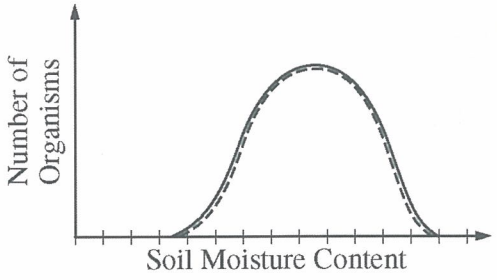


93. The diagrams above show the range of tolerance for soil moisture content for two different species of terrestrial invertebrate: Species 1 and Species 2. The ranges represented are for each species where it occurs alone. Soil moisture content is a limiting factor for both species. If populations of both species are placed together in a new location, which of the following diagrams represents the most likely actual (realized) ranges of the species' distribution of individuals with respect to soil moisture content after five generations?

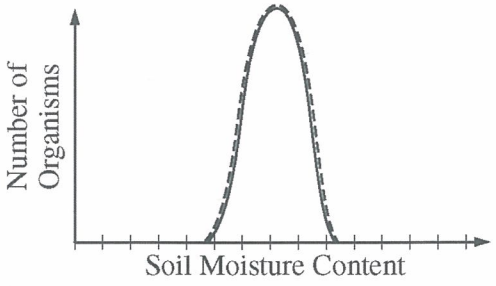
(A)



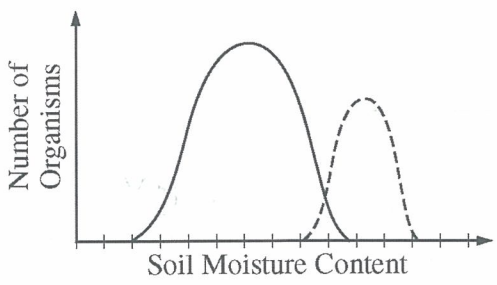
(B)



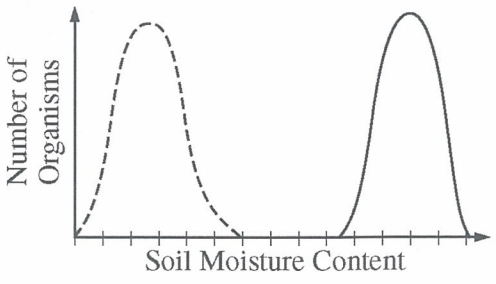
(C)



(D)



(E)



Unauthorized copying or reuse of any part of this page is illegal.

GO ON TO THE NEXT PAGE.

94. Overgrazing of grasslands can lead to reduced range quality. Two of the major effects of overgrazing are
(A) erosion and desertification
(B) higher fire potential and increased productivity
(C) eutrophication and increased methane production
(D) higher primary productivity and ammonification
(E) soil compaction and subsidence

95. Which of the following describes the heat-island effect?
(A) Urban areas trap more heat than rural areas do.
(B) Tropical islands reflect heat back into the atmosphere.
(C) Warm water in the Pacific causes excessive evaporation into the atmosphere.
(D) Lakes retain heat and provide warmth for landmasses nearby.
(E) Rapid decomposition in swamps releases a large amount of heat.

96. Losses of usable energy between successive trophic levels in an ecosystem are best accounted for by which of the following?
(A) The first law of thermodynamics
(B) The second law of thermodynamics
(C) The law of conservation of matter
(D) The process of ecological succession
(E) Limiting factors in the ecosystem

97. Which of the following actions would reduce global greenhouse emissions?
(A) Increasing the use of automobiles
(B) Decreasing the number of nuclear power plants
(C) Replacing coal-burning power plants with wind farms
(D) Converting tropical forests to rice paddies
(E) Switching from hydroelectric power generation to power generation using natural gas as the primary fuel

98. A home uses ten 100-watt lightbulbs for five hours per day. Approximately how many kilowatt-hours of electrical energy are consumed in one year by using the lightbulbs?
(A) 365
(B) 1,825
(C) 5,000
(D) 10,500
(E) 365,000

Unauthorized copying or reuse of any part of this page is illegal.

99. During an El Niño–Southern Oscillation event, which of the following best describes conditions in the eastern part of the tropical Pacific Ocean (e.g., near Peru and Ecuador) ?

	Sea Surface Temperature	Rainfall
(A)	Low	Low
(B)	Low	High
(C)	High	Low
(D)	High	High
(E)	High	Normal

100. True statements about ozone include which of the following?

I. It is a pollutant in the troposphere.
II. It filters out most of the UVC radiation in the stratosphere.
III. Most of it is formed in the stratosphere by reaction between carbon dioxide and free oxygen atoms.

(A) I only
(B) II only
(C) III only
(D) I and II only
(E) I, II, and III

STOP

END OF SECTION I

Unauthorized copying or reuse of any part of this page is illegal.

AP® Environmental Science Exam

SECTION II: Free-Response Questions

2008

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

At a Glance

Total Time
1 hour, 30 minutes
Number of Questions
4
Percent of Total Grade
40%
Writing Instrument
Pen with black or dark blue ink
Electronic Device
None allowed
Weight
The questions are weighted equally, but the parts of a question are not necessarily given equal weight.

IMPORTANT Identification Information

PLEASE PRINT WITH PEN:

1. First two letters of your last name ☐☐
   First letter of your first name ☐
2. Date of birth
   ☐☐ Month ☐☐ Day ☐☐☐☐ Year
3. Six-digit school code
   ☐☐☐☐☐☐
4. Unless I check the box below, I grant the College Board the unlimited right to use, reproduce, and publish my free-response materials, both written and oral, for educational research and instructional purposes. My name and the name of my school will not be used in any way in connection with my free-response materials. I understand that I am free to mark "No" with no effect on my score or its reporting.
   No, I do not grant the College Board these rights. ☐

Instructions

The questions for Section II are printed in the green insert and in this pink booklet. You may use the insert to organize your answers and for scratch work, but you must write your answers in the pink Section II booklet. No credit will be given for any work written in the insert.

Each answer should be organized, comprehensive, and in prose form; outline form is not acceptable. Do not spend time restating the questions or providing more than the number of examples called for. Extra examples will not earn points. Diagrams may be used to supplement discussion, but diagrams alone will not suffice.

Write clearly and legibly. Cross out any errors you make; crossed-out work will not be graded.

Manage your time carefully. You may proceed freely from one question to the next. You may review your responses if you finish before the end of the exam is announced.

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.

GO ON TO THE NEXT PAGE.

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

(i) microalgae

(ii) soybeans

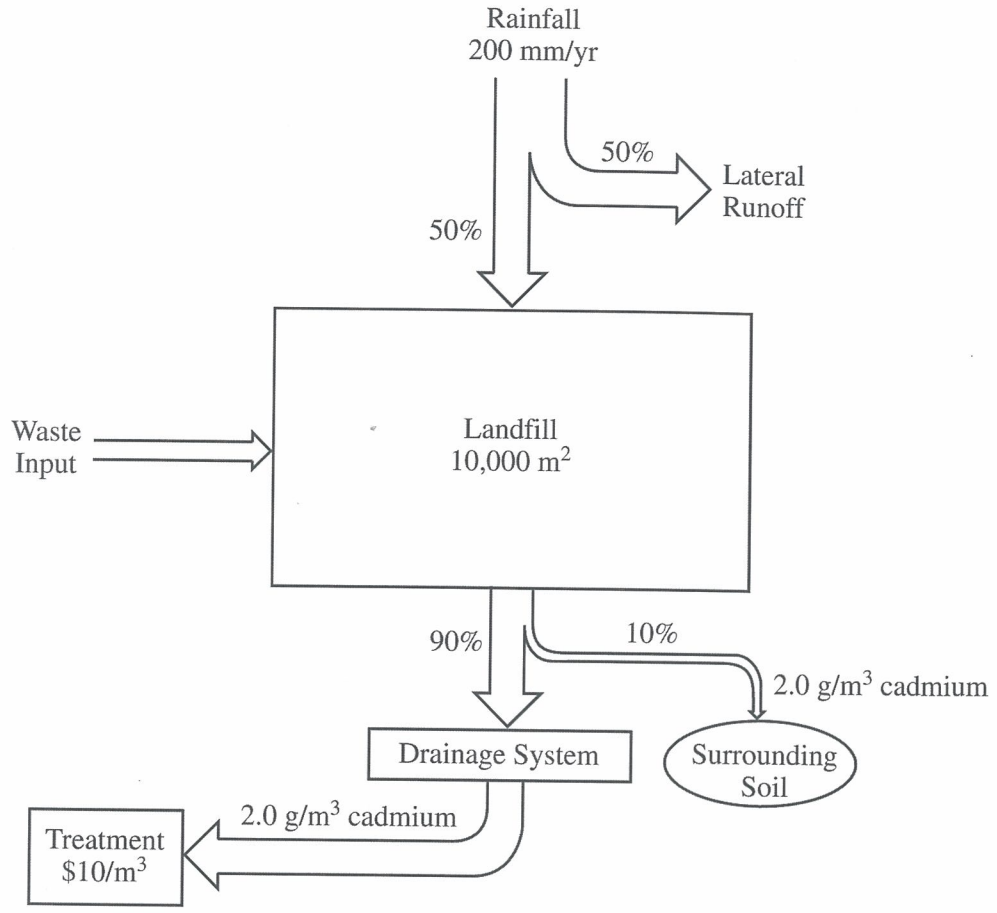
(b) Describe TWO environmental advantages that biodiesel production from microalgae offers over biodiesel production from the other crops listed in the table.

(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.

Section II



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).

GO ON TO THE NEXT PAGE.

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.

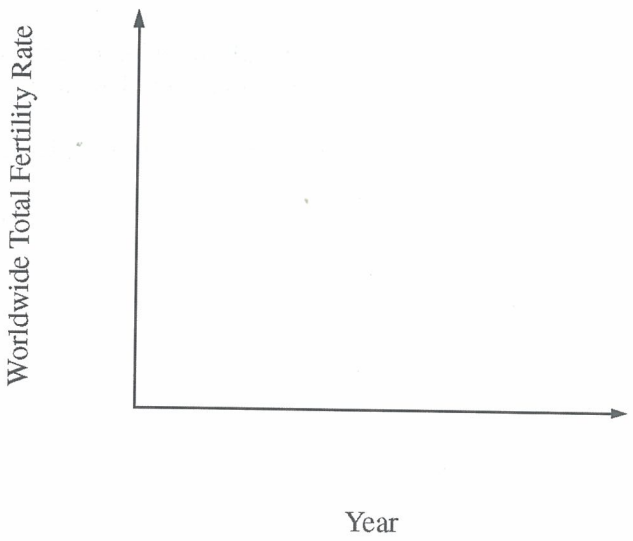
   (d) Identify a specific type of plant community or biome (other than a forest) that is naturally maintained by fire. Explain how the fire maintains the community or biome.

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.

GO ON TO THE NEXT PAGE.

STOP

END OF EXAM