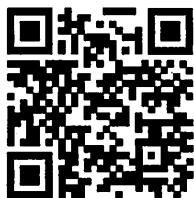


Practice Exams

Three additional tests are available online
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ANSWER SHEET

Practice Exam 1

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Practice Exam 1

With Answers and Analysis

SECTION I (MULTIPLE-CHOICE QUESTIONS)

Time: 90 minutes

100 questions

60% of total grade

No calculators allowed

This section consists of 100 multiple-choice questions. Mark your answers carefully on the answer sheet.

General Instructions

Do not open this booklet until you are told to do so by the proctor.

Be sure to mark your answers for Section I on the separate answer sheet. Use the test booklet for your scratch work or notes. Remember, though, that no credit will be given for work, notes, or answers written only in the test booklet. Once you have selected an answer, thoroughly blacken the corresponding circle on the answer sheet. To change an answer, erase your previous mark completely, and then record your new answer. Mark only one answer for each question.

Example

Sample Answer

The Pacific is

(A) (B) ● (D) (E)

- (A) a river
- (B) a lake
- (C) an ocean
- (D) a sea
- (E) a gulf

There is no penalty for wrong answers on the multiple-choice section, so you should answer all multiple-choice questions. Even if you have no idea of the correct answer, you should try to eliminate any obvious incorrect choices, and then guess.

Because it is not expected that all test takers will complete this section, do not spend too much time on difficult questions. First answer the questions you can answer readily. Then, if you have time, return to the difficult questions later. Do not get stuck on one question. Work quickly but accurately. Use your time effectively.

Directions: For each question or statement, select the one lettered choice that is the best answer and fill in the corresponding circle on the answer sheet.

1. Which of the following would be most likely to increase competition among the members of a squirrel population in a given area?
 - (A) An epidemic of rabies within the squirrel population
 - (B) An increase in the number of hawk predators
 - (C) An increase in the reproduction of squirrels
 - (D) An increase in temperature
 - (E) An increase in the food supply

2. Approximately how many years ago did life first appear on Earth?
 - (A) 1 million
 - (B) 500 million
 - (C) 1 billion
 - (D) 3.5 billion
 - (E) 5 billion

3. Which one of the following statements is FALSE?
 - (A) The greenhouse effect is a natural process that makes life on Earth possible with 98% of total global greenhouse gas emissions being from natural sources (mostly water vapor) and 2% from human-made sources.
 - (B) The United States is the number one contributor to global warming.
 - (C) The Kyoto Protocol would have required the United States to increase its greenhouse gas emissions—primarily carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O)—by only 2% per year based on 1990 levels.
 - (D) The effects of global warming on weather patterns may lead to adverse human health impacts.
 - (E) Global warming may increase the incidence of many infectious diseases.

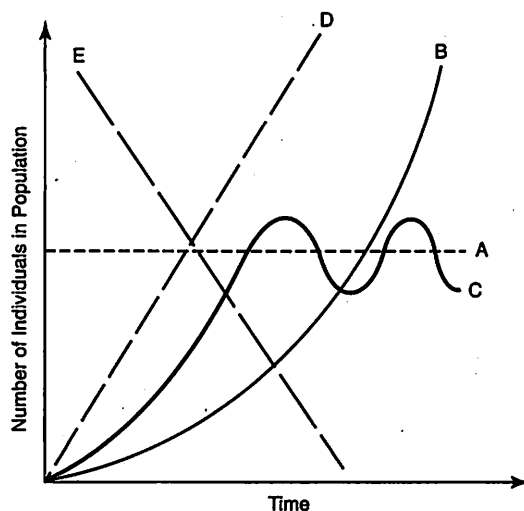
4. Which of the following would be an external cost?
 - (A) The cost of steel in making a refrigerator
 - (B) The cost of running a refrigerator for one month
 - (C) The cost of labor in producing refrigerators
 - (D) The taxes paid by consumers in purchasing refrigerators
 - (E) The costs associated with health care when the refrigerator leaks refrigerant into the atmosphere

5. In which stage of the nitrogen cycle do soil bacteria convert ammonium ions (NH_4^+) into nitrate ions (NO_3^-), a form of nitrogen that can be used by plants?
- (A) Nitrogen fixation
 - (B) Nitrification
 - (C) Assimilation
 - (D) Ammonification
 - (E) Denitrification
6. Which of the following is NOT an example of environmental mitigation?
- (A) Promoting sound land use planning, based on known hazards
 - (B) Relocating or elevating structures out of the floodplain
 - (C) Constructing living snow fences
 - (D) Organizing a beach cleanup
 - (E) Developing, adopting, and enforcing effective building codes and standards
7. Which of the following statements regarding an El Niño is FALSE?
- (A) Depression of the thermocline occurs, which cuts off cold water upwelling.
 - (B) A change in atmospheric pressures occurs and is associated with changing ocean water temperatures.
 - (C) El Niño affects weather patterns globally.
 - (D) An increase in greenhouse gases may increase the incidents of El Niños.
 - (E) Northeast and southeast trade winds increase.
8. Most of Earth's freshwater supply is found in
- (A) lakes
 - (B) ice caps and glaciers
 - (C) aquifers
 - (D) estuaries
 - (E) rivers
9. Most municipal solid wastes in the United States consist of
- (A) yard wastes
 - (B) food wastes
 - (C) plastic
 - (D) paper
 - (E) glass

10. Rising sea levels due to global warming would be responsible for all of the following EXCEPT
- (A) destruction of coastal wetlands
 - (B) beach erosion
 - (C) increases due to storm and flood damage
 - (D) increased salinity of estuaries and aquifers
 - (E) All would be the result of rising sea levels.
11. Which of the following characteristics are NOT typical of a ground fire?
- I. Fire smolders and/or creeps slowly through the litter and humus layers, consuming all or most of the organic cover, and exposing mineral soil or underlying rock.
 - II. Burns the upper litter layer and small branches that lie on or near the ground. Usually move rapidly through an area, and do not consume all the organic layer.
 - III. Release considerable amounts of nutrients from the burned fuels, destroy many small organisms and fungi that live in the humus and organic layers, consume seed stored in the litter, and kill roots in all but deep soil layers.
- (A) I only
 - (B) II only
 - (C) III only
 - (D) I and II
 - (E) I and III
12. Place the following economic activities in order, starting with those activities closest to natural resources and ending with those furthest away.
- I. Use raw materials to produce or manufacture something new and more valuable.
 - II. Professions that process, administer, and disseminate information (e.g., computer engineers and lawyers).
 - III. Agriculture, fishing, hunting, herding, forestry, and mining.
 - IV. Include all activities that amount to doing service for others (e.g., doctors and secretaries).
- (A) I, II, III, IV
 - (B) I, III, IV, II
 - (C) III, I, II, IV
 - (D) III, I, IV, II
 - (E) II, IV, I, III
13. Most of the municipal trash floating in the ocean is composed of
- (A) plastic
 - (B) paper
 - (C) wood
 - (D) metal cans
 - (E) yard wastes

14. Most of Earth's mass is found in this region, which is composed of iron, magnesium, aluminum, and silicon-oxygen compounds. At over 1800°F (1000°C), most of this region is solid but the upper third is more plastic-like in nature. Which region is being described?
- (A) Troposphere
 - (B) Lithosphere
 - (C) Crust
 - (D) Mantle
 - (E) Core
15. Which of the following statements regarding coral reefs is FALSE?
- (A) Modern reefs can be as much as 2.5 million years old.
 - (B) Coral reefs capture about half of all the calcium flowing into the ocean every year, fixing it into calcium carbonate rock at very high rates.
 - (C) Coral reefs store large amounts organic carbon and are very effective sinks for carbon dioxide from the atmosphere.
 - (D) Coral reefs are among the most biologically diverse ecosystems on the planet.
 - (E) Coral reefs are among the most endangered ecosystems on Earth.
16. Which of the following strategies to control pollution would incur the greatest governmental cost?
- (A) Green taxes
 - (B) Government subsidies for reducing pollution
 - (C) Regulation
 - (D) Charging a user fee
 - (E) Tradable pollution rights
17. In terms of annual production, which two crops listed below had the greatest success during The Green Revolution (1967–1978)?
- (A) Maize and corn
 - (B) Rice and corn
 - (C) Wheat and rice
 - (D) Wheat and maize
 - (E) Soybean and rice
18. In 1989, the *Exxon Valdez* spilled 10.8 million gallons of crude oil into Prince William Sound in Alaska. What happened to most of the oil?
- (A) It was cleaned up by Exxon.
 - (B) It eventually evaporated into the air.
 - (C) It sank into the ground.
 - (D) It biodegraded and photolyzed.
 - (E) It dispersed into the water column.

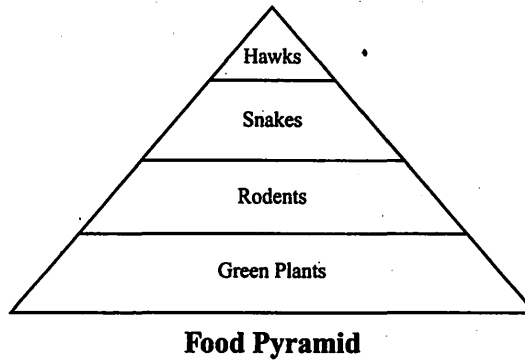
19. Which of the following contributes LEAST to speciation?
- (A) Sexual reproduction
 - (B) Asexual reproduction
 - (C) Selection
 - (D) Variation
 - (E) Isolation
20. Which act's primary goal is to protect human health and the environment from the potential hazards of waste disposal and calls for conservation of energy and natural resources, reduction in waste generated, and environmentally sound waste management practices?
- (A) RCRA
 - (B) FIFRA
 - (C) CERCLA
 - (D) OSHA
 - (E) FEMA
21. One of the earliest sites that utilized Superfund resources was
- (A) Bhopal, India
 - (B) Love Canal, New York
 - (C) Prince William Sound, Alaska
 - (D) Chernobyl, Ukraine
 - (E) Donora, Pennsylvania
22. Which growth curve best represents the effects of environmental resistance acting on a sustainable population?



- (A) A
- (B) B
- (C) C
- (D) D
- (E) E

23. The locations where two tectonic plates slide apart from each other with the space that was created being filled with molten magma from below, such as the Mid-Atlantic Ridge, the East Pacific Rise, and the East African Great Rift Valley, are known as
- (A) divergent boundaries
 - (B) convergent boundaries
 - (C) transform boundaries
 - (D) tectonic boundaries
 - (E) lithospheric boundaries
24. Radioactive materials, lead, arsenic, mercury, nickel, and benzene are all pollutants released from what type of electricity-generating plant?
- (A) Hydroelectric
 - (B) Solar
 - (C) Coal-burning
 - (D) Nuclear
 - (E) Natural gas
25. On Michigan's Keweenaw Peninsula, copper mills discharged an estimated 200 million tons of copper-contaminated waste directly into Torch Lake, reducing its volume by 20% and leaving a toxic threat to fish and anyone who eats the fish. Which law listed below would address the damage that has been done at Torch Lake?
- (A) 1872 Mining Act
 - (B) 1920 Mineral Leasing Act
 - (C) 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
 - (D) 1976 Resource Conservation and Recovery Act (RCRA)
 - (E) 1977 Surface Mining Control and Reclamation Act

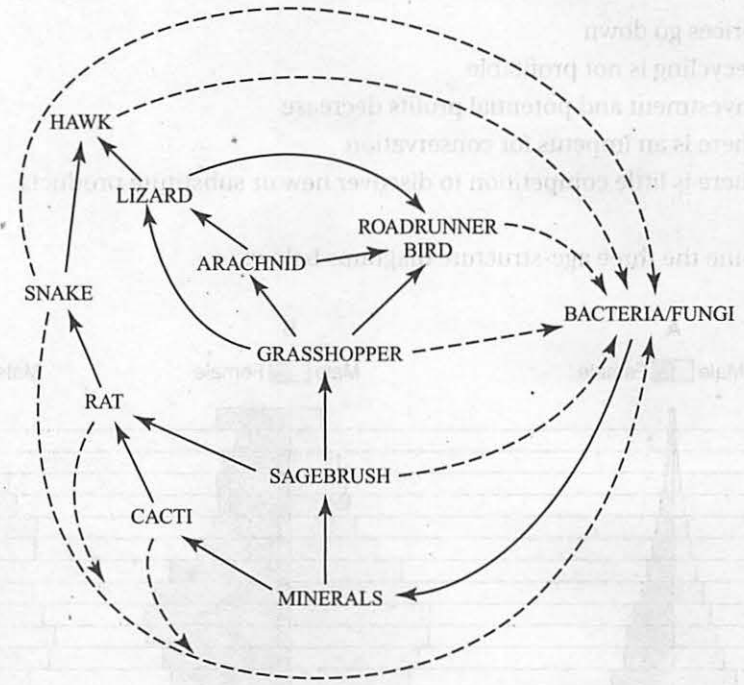
Base your answers to Questions 26 and 27 on the following diagram.



26. The greatest amount of energy present in this pyramid is found at the level of the
- (A) hawks
 - (B) snakes
 - (C) rodents
 - (D) green plants
 - (E) decomposers
27. The pyramid implies that in order to live and grow, 1,000 kilograms of snakes would require
- (A) less than 1,000 kilograms of green plants
 - (B) 1,000 kilograms of rodents
 - (C) more than 1,000 kilograms of rodents
 - (D) no rodents
 - (E) less than 1,000 kilograms of hawks
-
28. The type of planting in which an agricultural crop is grown simultaneously with a long-term tree crop to provide annual income while the tree crop matures is known as
- (A) crop rotation
 - (B) alley cropping
 - (C) monocropping
 - (D) sequential cropping
 - (E) intercropping
29. If a city with a population of 100,000 experiences 4,000 births, 3,000 deaths, 500 immigrants, and 200 emigrants within the course of one year, what is the net annual percentage growth rate?
- (A) 0.3%
 - (B) 1.3%
 - (C) 13%
 - (D) 101.3%
 - (E) 130%

30. The annual productivity of any ecosystem is greater than the annual increase in biomass of the herbivores in the ecosystem because
- (A) plants convert energy input into biomass more efficiently than animals
 - (B) there are always more animals than plants in any ecosystem
 - (C) plants have a greater longevity than animals
 - (D) during each energy transformation, some energy is lost
 - (E) animals convert energy input into biomass more efficiently than plants

Below is a diagram that shows the relationships that exist in an arid ecosystem. Base your answers to Questions 31 through 33 on the diagram and your knowledge of environmental science.

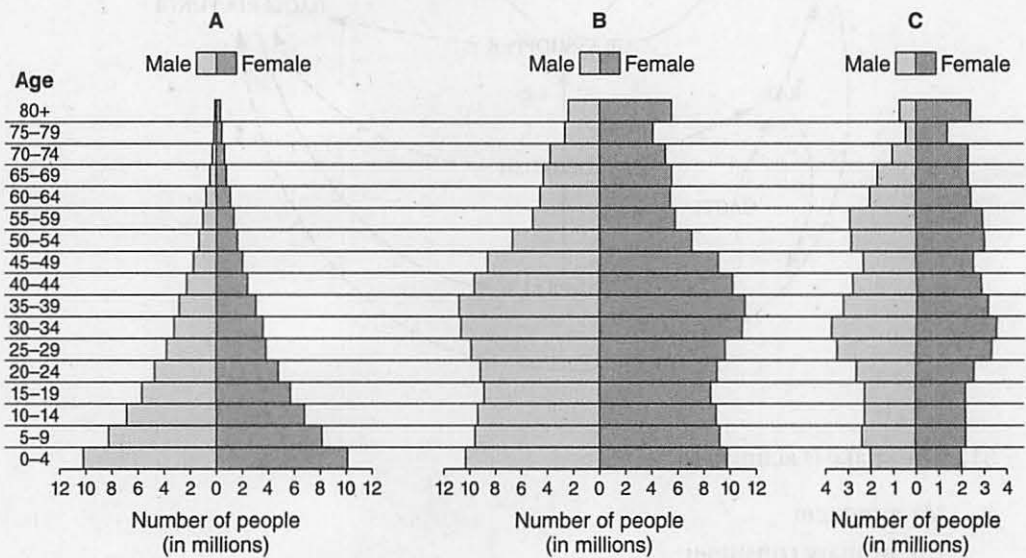


31. The snake is acting as a
- (A) producer
 - (B) primary consumer
 - (C) secondary consumer
 - (D) autotroph
 - (E) secondary producer
32. Between which two organisms would there MOST LIKELY be the greatest competition?
- (A) Rat and snake
 - (B) Lizard and arachnid
 - (C) Rat and roadrunner
 - (D) Grasshopper and bacteria/fungi
 - (E) Arachnid and roadrunner

33. In the diagram, which statement correctly describes the role of bacteria/fungi?
- (A) The bacteria/fungi convert radiant energy into chemical energy.
 - (B) The bacteria/fungi directly provide a source of nutrition for animals.
 - (C) The bacteria/fungi are saprophytic agents, restoring inorganic material to the environment.
 - (D) The bacteria/fungi convert atmospheric nitrogen into minerals and are found in the nodules of cacti.
 - (E) The bacteria/fungi consume live plants and animals.

34. When resources are scarce,
- (A) prices go down
 - (B) recycling is not profitable
 - (C) investment and potential profits decrease
 - (D) there is an impetus for conservation
 - (E) there is little competition to discover new or substitute products

35. Examine the three age-structure diagrams below:



Which of the age-structure diagrams above would be typical for a country experiencing a rapid rate of population growth?

- (A) A
- (B) B
- (C) C
- (D) B and C
- (E) None of the above

36. The annual amount of incoming solar energy varies considerably from tropical to polar latitudes with the polar regions radiating away more thermal energy than they absorb from the sun in the course of a year. The primary reason that the polar regions are not becoming progressively colder each year is because
- (A) large areas of upwelling in the polar seas keep heat circulating in the region
 - (B) as ice melts, it releases its heat energy to the surroundings
 - (C) the extensive cloud cover in the polar regions acts as a thermal blanket keeping whatever heat there is from escaping
 - (D) underground "hot spots" in the polar seas keep the ocean temperatures in the area fairly stable
 - (E) global heat energy is constantly being circulated through both ocean and air currents
37. Approximately five pounds of carbon is released into the atmosphere in the form of carbon dioxide for every gallon of gasoline that is burned. Two cars are making a 500 mile trip. Car A gets 15 miles to the gallon and car B gets 30 miles to the gallon. Approximately how much more carbon (in the form of CO_2) will car A produce than car B?
- (A) 5 pounds
 - (B) 16.7 pounds
 - (C) 33.3 pounds
 - (D) 83 pounds
 - (E) 100 pounds
38. Which factor does NOT significantly affect the amount of solar energy reaching the surface of Earth?
- (A) Earth's rotation once every 24 hours
 - (B) Earth's revolution around the sun once per year
 - (C) The tilt of Earth's axis (23.5°)
 - (D) Atmospheric conditions
 - (E) The distance between Earth and the sun
39. Other than the melting of glaciers and ice sheets, which of the following factors has made the largest contribution to the global rise in sea level over the past 100 years?
- (A) Urbanization and its impact on estuaries
 - (B) Melting of sea ice
 - (C) Increased river runoff
 - (D) Warming of ocean surface waters
 - (E) Increase in rainfall

40. A chain is dragged across the seafloor, pulling a huge net behind it. A single pass of this net can remove up to a quarter of seafloor life. Repeated passes can remove nearly all seafloor life, including sessile animals and plants plus many species of fish and marine invertebrates. This type of fishing is known as
- (A) bottom trawling or dredging
 - (B) chain-fishing
 - (C) scraping
 - (D) scoop netting
 - (E) drag-lining
41. Which of the following items should NOT be placed in a compost pile?
- I. Chemically treated wood products
 - II. Pet feces
 - III. Manure
 - IV. Pernicious weeds
 - V. Bones
- (A) II
 - (B) III
 - (C) IV
 - (D) I, II, IV, V
 - (E) I, II, III, IV, V
42. Two-thirds of Iceland's energy sources come from clean, renewable hydroelectric and geothermal sources. Research in Iceland is currently underway in developing hydrogen fuel cells. Iceland is an example of a country that is practicing
- (A) sustainability
 - (B) remediation
 - (C) conservation
 - (D) preservation
 - (E) mitigation
43. An electrical power plant that uses X joules of energy derived from natural gas can generate a maximum of Y joules of electrical energy within the same amount of time. Which of the following is always true?
- (A) $X = Y$ due to the law of conservation of energy.
 - (B) $X < Y$ due to the first law of thermodynamics.
 - (C) $X > Y$ due to the second law of thermodynamics.
 - (D) $X < Y$ due to the second law of thermodynamics.
 - (E) Depending upon the efficiency of the power plant, X could be equal to Y .

44. Which of the following statements are TRUE?
- I. The annual fluctuation of air temperature on landmasses influenced by polar cells is greater than the change in temperature occurring in a 24-hour cycle.
 - II. In landmasses influenced by polar cells, precipitation rather than temperature is the critical factor in plant distribution and soil development.
 - III. Landmasses influenced primarily by Ferrel cells have defined seasons with strong annual cycles of temperature and precipitation.
 - IV. Landmasses in equatorial regions primarily influenced by Hadley cells are characterized by low humidity and little precipitation.
 - V. Subtropical landmasses primarily influenced by Hadley cells are characterized by high relative humidity and tropical forests.
- (A) I and III
(B) I, II, and IV
(C) II and III
(D) III and V
(E) I, II, IV, and V
45. As urban environments become more dense, noise pollution is becoming a major environmental issue as people deal with noise generated from flight paths, freeways, work environments, and neighborhoods. Which of the following is a TRUE statement?
- (A) Loud sound is not dangerous as long as you do not feel any pain in your ears.
(B) Hearing loss after sound exposure is temporary.
(C) Hearing loss is caused mostly by aging.
(D) Loud sound damages only your hearing.
(E) If you have a hearing loss already, you still have to protect your hearing.
46. What is meant by the term "enriched" uranium?
- (A) Pure uranium, with no other elements present
(B) All nuclei are U-238 in the sample
(C) Uranium that has been rinsed in heavy water to enrich it
(D) Uranium that has a higher proportion of U-235 nuclei than normal
(E) Uranium that has had plutonium added to it
47. Which of the following is NOT a benefit associated with Integrated Pest Management (IPM)?
- (A) More reliable and effective pest control
(B) Reduction in the use of the most hazardous pesticides
(C) Lessening the chance of pesticide resistance developing
(D) Total elimination of pest species
(E) All of the choices are benefits of integrated pest management.

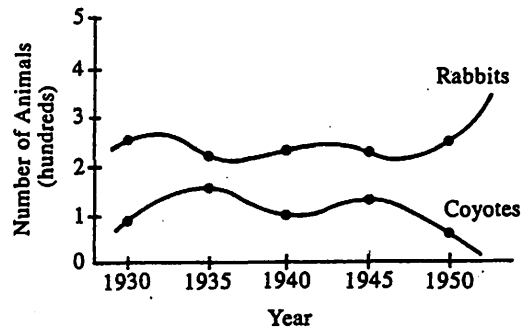
48. Which of the following statements about the role of carbon dioxide (CO_2) in the carbon cycle are TRUE?
- I. Carbon dioxide is produced during photosynthesis.
 - II. Carbon dioxide concentration in the atmosphere decreases when trees are cut down and the trees decay.
 - III. The primary nonanthropomorphic source of carbon dioxide is outgassing from Earth's interior.
- (A) I only
(B) II only
(C) III only
(D) II and III only
(E) I, II, and III

Questions 49 and 50 refer to the following air pollutants.

- (A) Nitrogen dioxide (NO_2)
(B) Peroxyacetyl nitrates (PANs)
(C) Volatile organic compounds (VOCs)
(D) Ozone (O_3)
(E) Particulates (PM_{10})
49. Powerful respiratory and eye irritants present in photochemical smog. They are secondary air pollutants, not directly emitted as exhaust from power plants or internal-combustion engines, and formed from other pollutants by chemical reactions in the atmosphere.
50. Commonly found in paints and solvents. Examples include benzene, acetone, and formaldehyde.
-
51. Most commercial fish are caught in which ocean?
- (A) Atlantic
(B) Indian
(C) Arctic
(D) Southern
(E) Pacific
52. Why is the bioaccumulation of harmful chemicals especially destructive in species such as salmon?
- (A) Salmon migrate long distances, allowing them to spread harmful chemicals into many different ecosystems.
(B) Salmon are tertiary consumers and are at the top of the food pyramid.
(C) Salmon are a keystone species, meaning they are "key" in the health of the ecosystem(s) they inhabit.
(D) Salmon are an increasingly endangered species.
(E) All of the above are true.

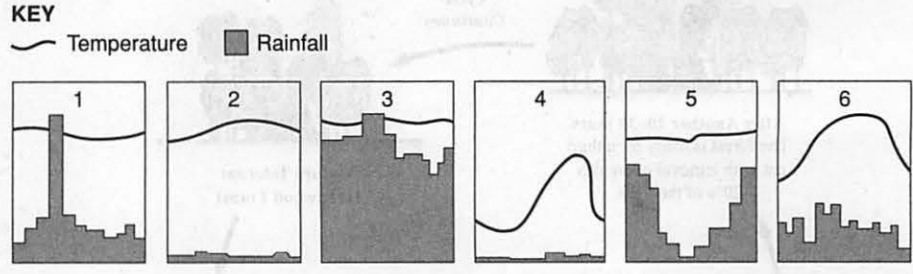
53. Characteristics typical of an oligotrophic lake include which of the following?
- I. High dissolved oxygen content
 - II. High primary productivity
 - III. Clear water
- (A) I only
 - (B) II only
 - (C) III only
 - (D) I and III only
 - (E) I, II, and III
54. Which federal agency listed below does NOT manage designated federal wilderness areas in the United States?
- (A) National Park Service
 - (B) Forest Service
 - (C) Bureau of Land Management
 - (D) Fish and Wildlife Service
 - (E) All share management
55. The greatest environmental impact of using fluorescent and/or compact fluorescent lightbulbs (CFL) is that they
- (A) are not energy efficient
 - (B) contain mercury
 - (C) take much longer to start than incandescent lightbulbs
 - (D) are more expensive compared to incandescent lightbulbs
 - (E) All of the above
56. A compact fluorescent lightbulb (CFL) used for lighting has an efficiency rating of 10%. For every 10.00 joule of electrical energy consumed by the lightbulb, which of the following is produced?
- (A) 0.90 joule of light energy
 - (B) 1.00 joule of light energy
 - (C) 9.00 joules of light energy
 - (D) 9.90 joules of heat energy
 - (E) 9.90 joules of light energy

In 1940, ranchers introduced cattle into an area. The graph below shows the effect of cattle ranching on the populations of two organisms present in the area before the introduction of the cattle. Base your answers to Questions 57 and 58 on the graph and on your knowledge of environmental science.



57. The most probable reason for the increase in the rabbit population after 1950 was
- (A) more food became available to the rabbits
 - (B) the coyote population declined drastically
 - (C) the cattle created a more favorable environment for the rabbits
 - (D) the coyotes and cattle competed for the same food
 - (E) the coyote population increased
58. If the interrelationship of rabbits and coyotes was once in balance, what is the most probable explanation for the decline of the coyotes?
- (A) Mutations
 - (B) Starvation
 - (C) Disease
 - (D) Increase in reproductive rate
 - (E) Removal by human beings

Questions 59 and 60 refer to the following graphs of temperature and rainfall for six major ecosystems. A year's temperature from January through December (the line) and rainfall pattern (the shaded area) of each ecosystem are shown.



59. Which of the climatograms represents a savanna?
- (A) 1
 - (B) 2
 - (C) 3
 - (D) 5
 - (E) 6

60. Which represents a tundra?
- (A) 1
 - (B) 2
 - (C) 3
 - (D) 4
 - (E) 5

61. Which form of timber harvesting is represented above?

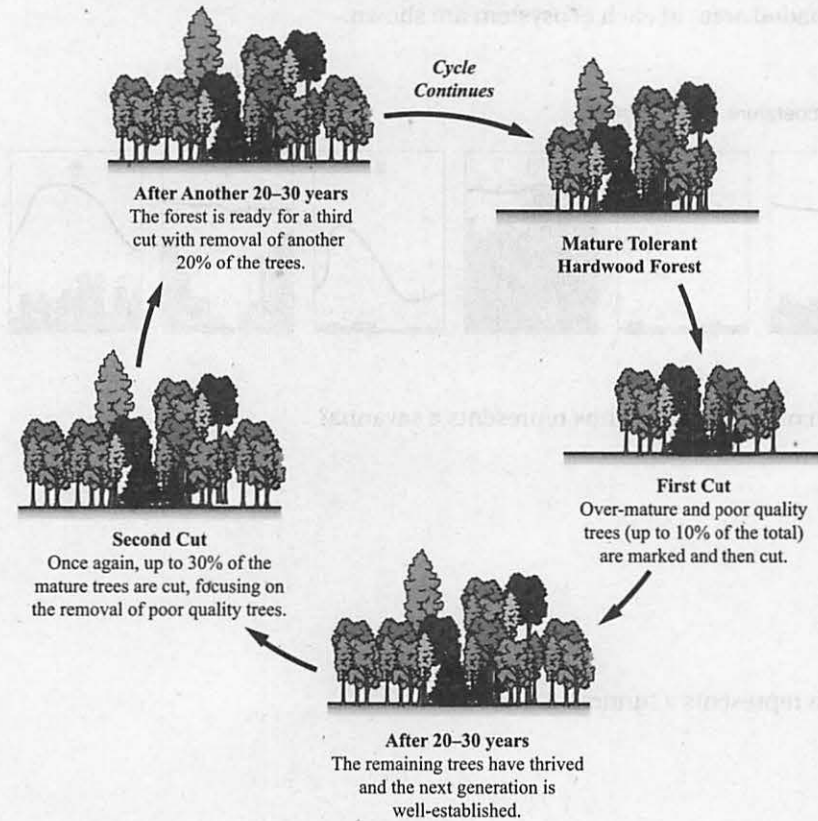
- (A) Clear-cutting
- (B) Shelterwood cutting
- (C) Selective cutting
- (D) Seed-tree harvesting
- (E) Skidding of the slope

62. Rank the following biomes in order of most productive to least productive as measured by biomass produced per year.

- I. Desert
- II. Tropical rainforest
- III. Tundra
- IV. Grassland

- (A) I, II, III, IV
- (B) IV, III, II, I
- (C) III, I, IV, II
- (D) II, III, IV, I
- (E) II, IV, III, I

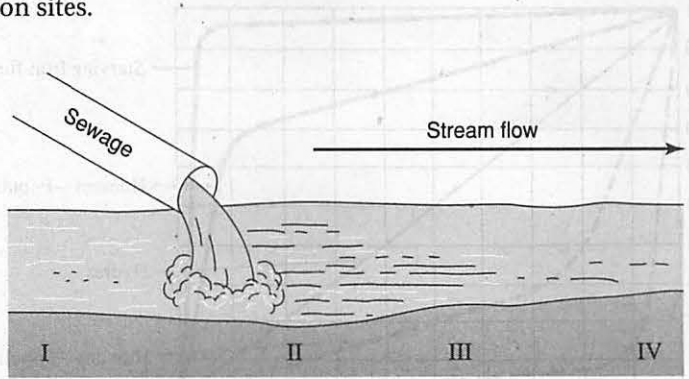
Examine the timber cutting cycle below for Question 61.



61. Which form of timber harvesting is represented above?
- (A) Clear-cutting
 (B) Shelterwood cutting
 (C) Selective cutting
 (D) Seed-tree harvesting
 (E) None of the above
62. Rank the following biomes in order of most productive to least productive, as measured by biomass produced per acre.
- I. Desert
 II. Tropical rainforests
 III. Tundra
 IV. Grassland
- (A) I, II, III, IV
 (B) IV, III, II, I
 (C) III, I, IV, II
 (D) II, III, IV, I
 (E) II, IV, III, I

63. Kerosene, gasoline, motor oil, asphalt, tar, waxes, and diesel fuel all come from crude oil. Refineries take advantage of what physical property in order to separate these components from the original crude oil?
- (A) Solubility
 - (B) Freezing point
 - (C) Density
 - (D) Boiling point
 - (E) Viscosity

64. Refer to the data below taken from a stream. The Roman numerals indicate collection sites.



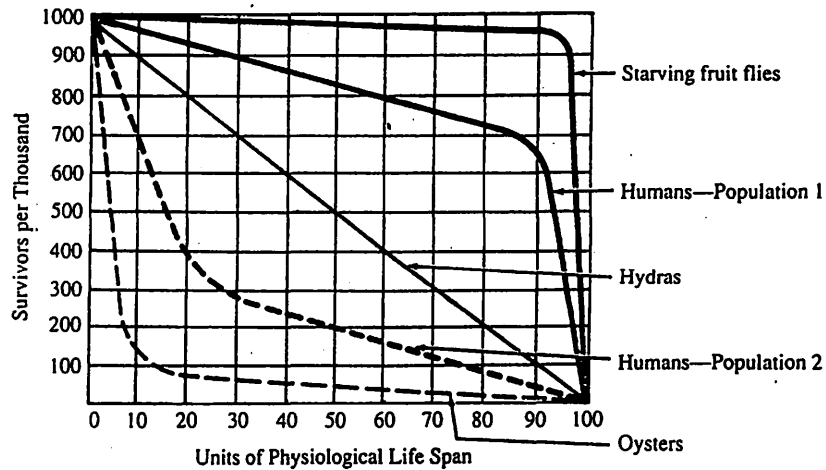
Where would the lowest DO (dissolved oxygen) content be expected?

- (A) I
 - (B) II
 - (C) III
 - (D) IV
 - (E) Dissolved oxygen would not be affected by sewage effluent. Therefore, DO would be equal at all points.
65. The theory that great disasters serve to maintain a population and its food supply balance was initially proposed by
- (A) Darwin
 - (B) Wallace
 - (C) Hardy and Weinberg
 - (D) Malthus
 - (E) Lyell

The following graph shows survival rates for five animal populations. When survival curves are calculated, the following assumptions are made:

- I. All individuals of a given population are the same age.
- II. No new individuals enter the population.
- III. No individuals leave the population.

These curves show the relationship of the number of individuals in a population to units of physiological life span. Base your answers to Questions 66 and 67 on the graph and on your knowledge of environmental science.

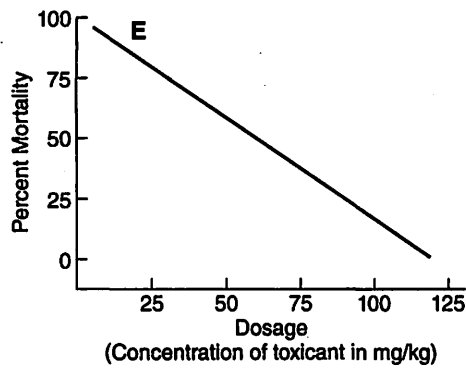
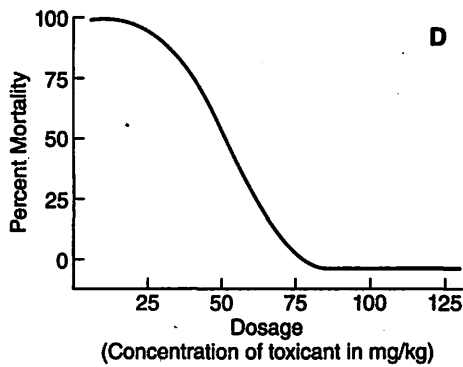
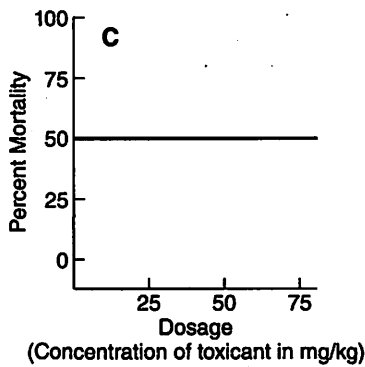
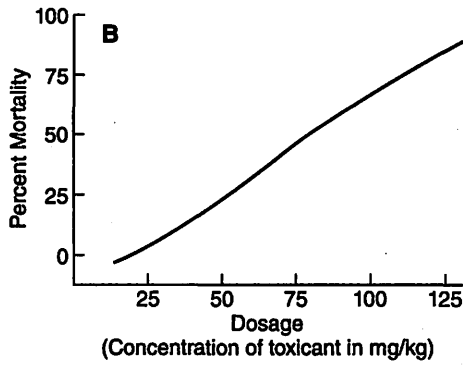
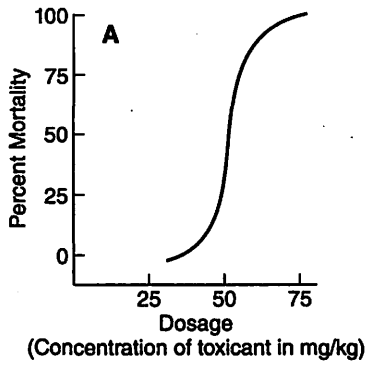


66. According to the data, it can be assumed that
- (A) fruit flies live longer than humans
 - (B) oysters outlive fruit flies
 - (C) the population of hydras is steadily declining
 - (D) the life span of human populations is related to that of oysters
 - (E) there is a high mortality rate among young oysters
67. The survival curves indicate that
- (A) starving fruit flies live out their full life span
 - (B) human populations are more vulnerable than hydras
 - (C) human population 2 has a greater rate of survival than human population 1
 - (D) the hydra has a longer life span than the oyster
 - (E) fruit flies die directly after pupation

68. The average requirement for drinking water per person per day is approximately
- (A) 1 pint
 - (B) 1 cup
 - (C) 1 quart
 - (D) 2 quarts ($\frac{1}{2}$ gallon)
 - (E) 2 gallons
69. Which of the following is NOT a principle of Integrated Pest Management (IPM)?
- (A) Establish acceptable pest levels, called action thresholds, and apply controls if those thresholds are crossed.
 - (B) When insects are found, apply pesticides early so that insect biological life cycles are disrupted to the point that they are unable to multiply.
 - (C) Select crop varieties best suited for local growing conditions.
 - (D) Use mechanical and/or biological controls prior to the application of pesticides.
 - (E) Regularly observe, monitor, and record crop conditions.
70. The world's population in 2010 was approximately 7 billion. If the population growth rate was 2%, in what year would the world's population have doubled to 14 billion?
- (A) 2020
 - (B) 2045
 - (C) 2090
 - (D) 2100
 - (E) 2110
71. In 1900 the amount of carbon dioxide gas released into the atmosphere by human activity was estimated to be 250 million metric tons per year. By the year 2000, this amount had increased to just over 350 million metric tons per year. What is the approximate percent increase in the carbon dioxide concentration from 1900 to 2000?
- (A) 20%
 - (B) 40%
 - (C) 80%
 - (D) 120%
 - (E) 150%

72. Which of the following is NOT an acceptable mitigation technique used to reverse the process of desertification?
- (A) Fixating the soil through the use of shelterbelts, woodlots, and windbreaks
 - (B) Hyperfertilizing the soil
 - (C) Encouraging large-scale cultivation of the land to hold the soil in place
 - (D) Reforestation
 - (E) Provisioning the water
73. Which of the following statements is NOT consistent with “The Tragedy of the Commons” by Garret Hardin?
- (A) We will always add one too many cows to the village commons, destroying it.
 - (B) The destruction of the commons will not be stopped by shame, moral admonitions, or cultural mores anywhere nearly so effectively as it will be by the will of the people expressed as a protective mandate, in other words, by government.
 - (C) The “Tragedy of the Commons” is a modern phenomenon. Humans were not capable of doing too much damage until the population exceeded certain numbers and their technological tools became powerful beyond a certain point.
 - (D) A free-market economy, based on capitalism, does not contribute to the “Tragedy of the Commons.”
 - (E) We will always opt for an immediate benefit at the expense of less-tangible values such as the availability of a resource to future generations.
74. The most common method of disposing of municipal solid wastes in the United States is
- (A) incineration
 - (B) ocean dumping
 - (C) sanitary landfills
 - (D) recycling
 - (E) exporting
75. Place the following events in sequential order:
- I. Atmospheric CO₂ increases
 - II. Warmer Ocean
 - III. Warmer Atmosphere
 - IV. Less CO₂ uptake by the oceans
- (A) I → II → III → IV
 - (B) I → III → II → IV
 - (C) IV → II → I → III
 - (D) II → III → I → IV
 - (E) III → II → I → IV

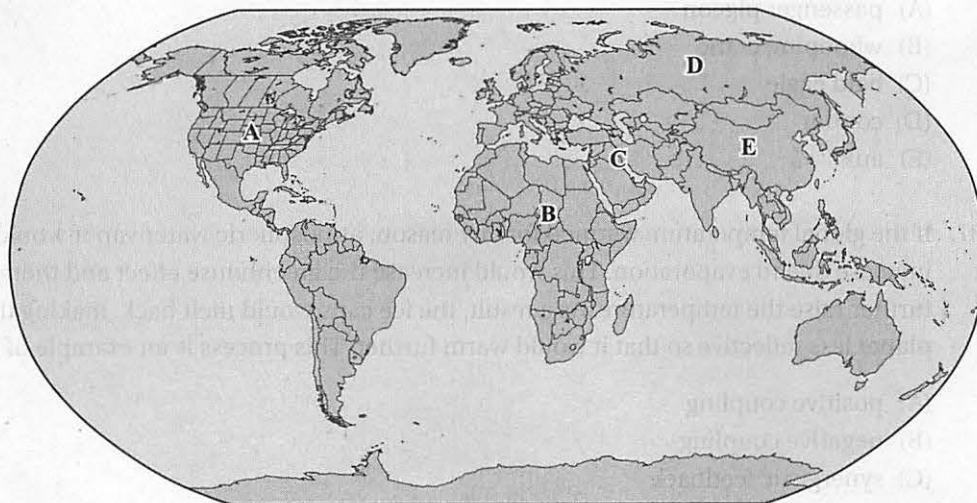
76. A new wide-range pesticide was being tested for efficacy on five species of insects. Which of the graphs below represents the insect species that would have the greatest potential over time for developing resistance to the pesticide?



- (A) A
- (B) B
- (C) C
- (D) D
- (E) E

77. The densest populations of most organisms that live in the ocean are found near the surface. The most probable explanation is that
- (A) the surface is less polluted
 - (B) the bottom contains radioactive material
 - (C) saltwater has more minerals than freshwater
 - (D) the light intensity that reaches the ocean decreases with increasing depth
 - (E) the largest primary consumers are found near the surface
78. Of the following sources of pollution, which would NOT be classified as a point source of pollution?
- I. Sulfur oxides released from an electrical generating plant
 - II. Oil, grease, and toxic chemicals showing up in a stream
 - III. Cyanide leaking from a heap leach pile at an abandoned gold mine site
 - IV. Diesel exhaust soot coming from trucks on the interstate
- (A) I and III
 - (B) I and IV
 - (C) II and IV
 - (D) I, III, and IV
 - (E) I, II, III, and IV
79. Certain volcanoes are built almost entirely of fluid lava flows that pour out in all directions from a central summit vent or groups of vents. They build a broad, gently sloping, dome-shaped cone. These cones are built up slowly by the accretion of thousands of highly fluid basalt lava flows that spread widely over great distances and then cool as thin, gently, dipping sheets. These types of volcanoes are known as
- (A) lava domes
 - (B) composite volcanoes
 - (C) cinder cones
 - (D) shield volcanoes
 - (E) stratovolcanoes
80. Of the causes of preventable deaths in the United States listed below, which one causes the MOST deaths per year?
- (A) AIDS
 - (B) Illegal drug use
 - (C) Alcohol use
 - (D) Smoking
 - (D) Motor vehicle accidents

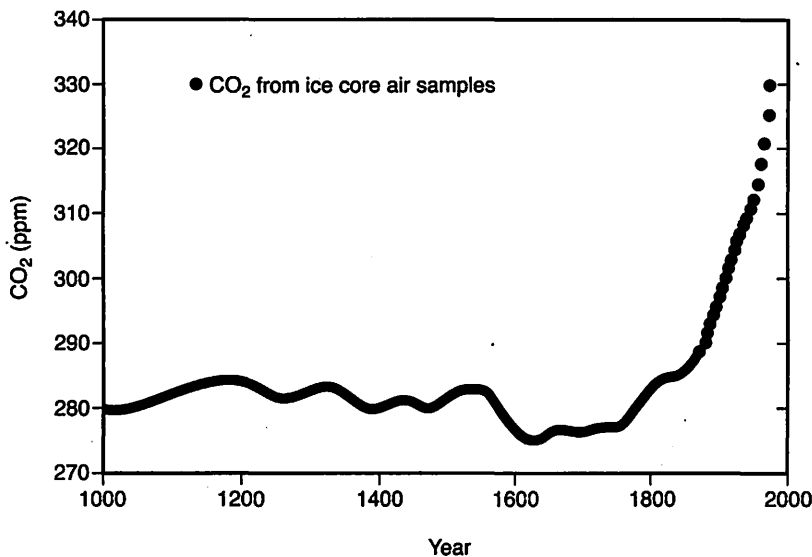
Questions 81–83 refer to the locations marked by letters in the world map below.



81. The location with the greatest oil reserves.
82. The area with the greatest coal reserves.
83. The area with the greatest natural gas reserves.
-
84. Which pair of compounds listed below reacts with H_2O to produce acid rain?
- (A) NH_3 and SO_2
 - (B) CO and SO_2
 - (C) CO_2 and H_2O_2
 - (D) SO_3 and NO_3
 - (E) SO_2 and NO_x
85. If current population trends continue, which regions of the world will experience the greatest population growth in the next 25 years?
- I. Central and South America
 - II. Africa
 - III. Asia
- (A) I only
 - (B) II only
 - (C) III only
 - (D) I and II
 - (E) II and III

86. One of the greatest successes of the Endangered Species Act has been the
- (A) passenger pigeon
 - (B) whooping crane
 - (C) bald eagle
 - (D) condor
 - (E) auk
87. If the global temperature warmed for any reason, atmospheric water vapor would increase due to evaporation. This would increase the greenhouse effect and thereby further raise the temperature. As a result, the ice caps would melt back, making the planet less reflective so that it would warm further. This process is an example of (a)
- (A) positive coupling
 - (B) negative coupling
 - (C) synergistic feedback
 - (D) positive feedback loop
 - (E) negative feedback loop
88. The most abundant nonanthropogenic greenhouse gas is
- (A) water vapor
 - (B) carbon dioxide
 - (C) nitrogen
 - (D) methane
 - (E) tropospheric ozone
89. What is the most frequent cause of beach pollution?
- (A) Polluted runoff and storm water
 - (B) Sewage spills from treatment plants
 - (C) Oil spills
 - (D) Ships dumping their holding tanks into coastal waters
 - (E) People leaving their trash on the beach
90. Atmospheric carbon dioxide levels
- (A) are about 10% higher than they were at the time of the Industrial Revolution
 - (B) are about 25% higher than they were at the time of the Industrial Revolution
 - (C) are about the same as they were at the time of the Industrial Revolution
 - (D) are slightly lower than they were at the time of the Industrial Revolution
 - (E) are significantly lower than they were at the time of the Industrial Revolution

For Question 91, use the following information: A scientific study took ice core samples to measure the concentration of carbon dioxide that was present in the atmosphere for the last 1,000 years. Their findings are shown below:



91. Which of the following mathematical setups could be used to determine the approximate percentage increase in the carbon dioxide concentration over the last 1,000 years (use the year 1000 as the base year for comparison)?

(A) $\frac{330 \text{ ppm} - 280 \text{ ppm}}{280 \text{ ppm}} \times 100\%$

(B) $\frac{330 \text{ ppm} + 280 \text{ ppm}}{2} \times 100\%$

(C) $\frac{330 \text{ ppm} - 280 \text{ ppm}}{50 \text{ ppm}} \times 100\%$

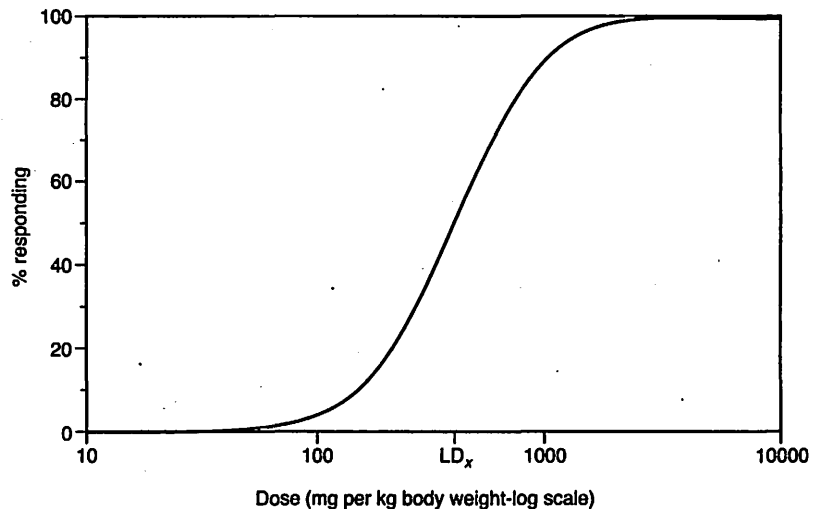
(D) $\frac{330 \text{ ppm} + 280 \text{ ppm}}{330 \text{ ppm}} \times 100\%$

(E) $\frac{330 \text{ ppm} + 280 \text{ ppm}}{50 \text{ ppm}} \times 100\%$

92. The major sink for phosphorus is

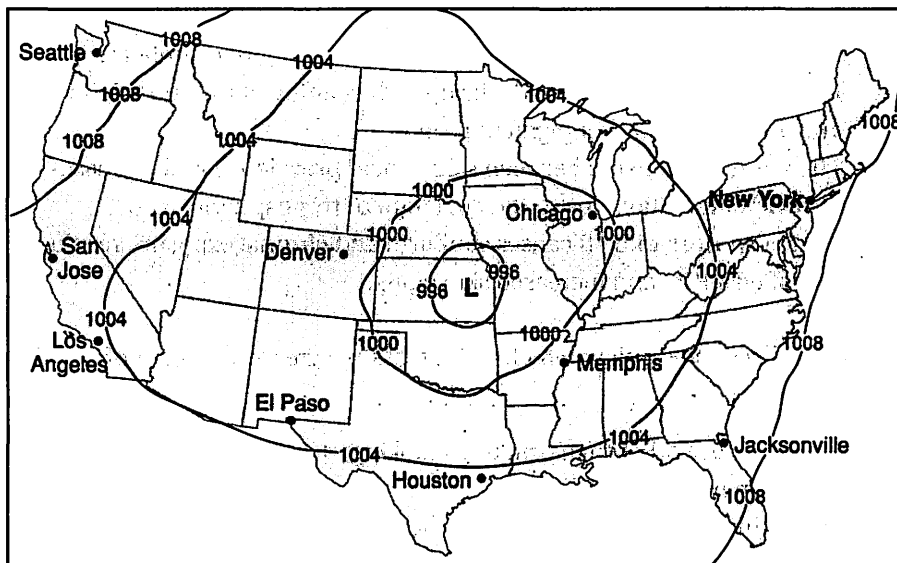
- (A) marine sediments
- (B) atmospheric gases
- (C) seawater
- (D) plants
- (E) animals

93. A large agricultural company that manufactures pesticides had developed a new insecticide to kill a certain species of aphid that was damaging citrus crops. After repeated testing using rats, the results are presented below. Which of the following statements listed below is the most accurate statement regarding this insecticide?



- (A) Any aphid receiving 400 mg of this insecticide will die.
- (B) For every 100 rats exposed to 400 mg of this insecticide, 50 will die.
- (C) For every one kilogram of aphids receiving 400 mg of this insecticide, 50% of them will die.
- (D) Out of 100 rats each receiving a dose of 400 mg of this insecticide per kilogram of body weight, 50 will die.
- (E) Out of 100 people exposed to 400 mg of this insecticide, 50 will become acutely ill and die.
94. Which of the following would NOT be a likely location for seismic activity?
- (A) Along mid-oceanic ridges
- (B) Faults associated with volcanic activity
- (C) Boundaries between oceanic and continental plates
- (D) Interior of continental plates
- (E) Boundaries between continental plates

95. Which of the following statements is correct for the third stage of the demographic transition model?
- (A) Birth rate increasing, death rate falling, total population increasing
 - (B) Birth rate low, death rate low, total population high and constant
 - (C) Birth rate falling, death rate high, total population increasing
 - (D) Birth rate falling, death rate falling, total population increasing
 - (E) Birth rate high, death rate low, total population high and constant
96. Examine the following weather map.



- Which of the following would be TRUE?
- (A) It is likely to be fair weather in the Midwest.
 - (B) It is likely to be raining in the Midwest.
 - (C) It is likely to be raining in the Northeast.
 - (D) Rain would be expected in the western United States.
 - (E) Not enough information is provided
97. The concentration of H^+ ions in a solution with a pH value of 3 is how many times as great as the concentration of H^+ ions in a solution with a pH of 6?
- (A) 2
 - (B) 3
 - (C) 100
 - (D) 1,000
 - (E) 10,000

98. Causes of sick building syndrome include all of the following EXCEPT
- (A) radon and asbestos
 - (B) chemical contaminants from indoor sources
 - (C) chemical contaminants from outdoor sources
 - (D) biological contaminants
 - (E) inadequate ventilation
99. Which of the following statements is FALSE?
- (A) Evidence exists of a dose-response relationship between nonmelanoma skin cancer and cumulative exposure to UVB radiation.
 - (B) Individuals, usually those living in areas with limited sunlight and long, dark winters, may suffer severe photo allergies to the UVB in sunlight.
 - (C) Increased absorption of UVB triggers a thickening of the superficial skin layers and an increase in skin pigmentation.
 - (D) There is a relationship between skin cancer prevalence and increases in ultraviolet radiation due to the depletion of tropospheric ozone.
 - (E) Acute exposure to UVB causes sunburn, and chronic exposure results in the loss of elasticity and increased skin aging.
100. Of the choices listed below, which constitutes the greatest percent of global freshwater use?
- (A) Domestic use other than drinking (cooking, flushing toilets, showering, etc.)
 - (B) Use in energy production
 - (C) Agriculture
 - (D) Industry
 - (E) Drinking

SECTION II (FREE-RESPONSE QUESTIONS)

Time: 90 minutes

4 questions

40% of total grade

No calculators allowed

Directions: Answer all four questions, which are weighted equally. The suggested time is about 23 minutes for answering each question. Write all your answers on scrap paper. Where calculations are required, clearly show how you arrived at your answer. Where an explanation or discussion is required, support your answers with relevant information and/or specific examples.

1. The environmental impact of washing a load of clothes in an electric washing machine is different than washing the same clothes by hand. Use the information below to answer the questions that follow. Show your calculations.

Assume the following:

1. All of the clothes can be washed in one load in the washing machine.
2. The water entering the water heater is 60°F
3. The water leaving the water heater is 130°F
4. The electric washing machine uses 20 gallons of water. It uses 110 volts of electricity at an average of 1,500 watts for 30 minutes.
5. Washing the clothes by hand requires 35 gallons of hot water.

Other information:

1 gallon of water = 8 pounds

1 Btu = amount of energy required to raise the temperature of 1 pound of water by 1°F

1 kilowatt-hour = 3,400 Btu

- (a) Calculate the total amount of energy (in Btu) to wash the clothes using the washing machine.
- (b) Calculate the total amount of energy (in Btu) to wash the clothes by hand.
- (c) Discuss the economic and environmental costs and benefits of using a washing machine in terms of
 - (i) its manufacture and disposal
 - (ii) selecting one and purchasing it (specifically, how can consumers compare various appliances in terms of their energy use)
 - (iii) steps consumers can take to reduce its environmental impact

2. An AP Environmental Science class did an investigation on competition. Part I of the investigation focused on intraspecific competition to assess the effect of growth among radish plants at different population densities. Part II of the investigation focused on the relative competitiveness of two species of plants (radish and wheat) when they were planted together. The results are presented below:

**Part I: Intraspecific Competition
Among Radish Plants**

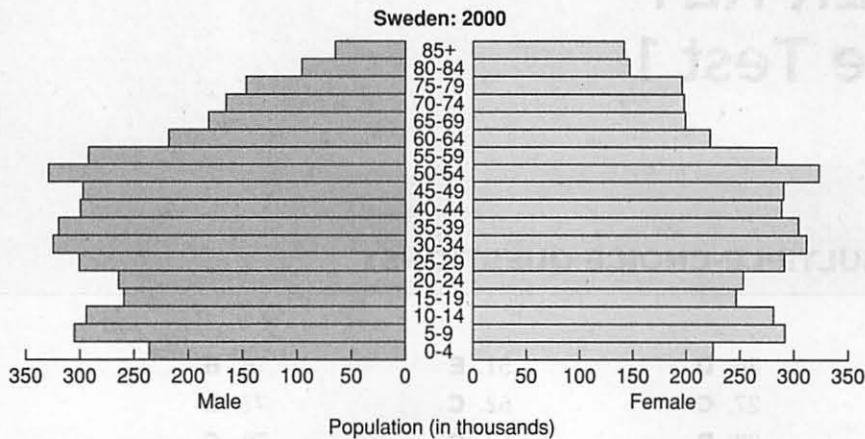
Seeds per Pot	Total Biomass per Pot (g)
1	5.0
10	70.0
20	75.0

**Part II: Interspecific Competition
Between Radish and Wheat Plants**

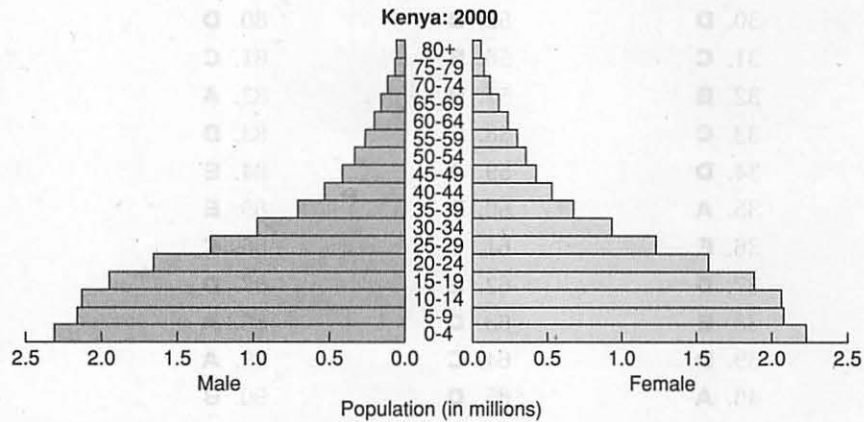
Seeds per Pot	Total Biomass per Pot (g)
1 radish	5.0
1 wheat	3.0
10 radish	50.0
10 wheat	25.0
20 radish	75.0
20 wheat	40.0

- (a) Discuss the results of Part I of the investigation.
- At what population density was the biomass per plant highest?
 - Identify and describe TWO resources that may have been limited.
 - Discuss the results obtained from the class for Part I in terms of two biological laws or principles.
- (b) Discuss the results of Part II of the investigation.
- Which plant was most affected by the competition between the two species?
 - Describe TWO possible reasons why the plant chosen in (i) may have been more successful.
 - Discuss the results obtained from the class for Part II in terms of two biological laws or principles.

3. Examine the age-structure diagrams of Sweden and Kenya below, and answer the following questions.



Source: U.S. Census Bureau, International Data Base.



Source: U.S. Census Bureau, International Data Base.

- (a) Compare and contrast the two age-structure diagrams in terms of two population dynamics—birth rate and death rate.
- (b) What factors affect birth rates and death rates?
- (c) Discuss methods that have been employed in another country to curb population growth.
4. Pesticides have become the most widely used form of pest management and are a controversial topic in environmental science.
- (a) Explain what a pesticide is.
- (i) Describe TWO major categories of pesticides. For example: Insecticide—kills insects and other arthropods. (Do NOT use insecticide as one of your categories.)
 - (ii) Identify and discuss TWO positive effects of pesticide use.
 - (iii) Identify and discuss TWO negative effects of pesticide use.
- (b) Discuss any TWO alternatives to the use of pesticides.
- (c) Name and describe ONE U.S. federal law OR ONE international treaty that focuses on the use of pesticides.

ANSWER KEY

Practice Test 1

SECTION I (MULTIPLE-CHOICE QUESTIONS)

- | | | | |
|--------------|--------------|--------------|---------------|
| 1. C | 26. D | 51. E | 76. B |
| 2. D | 27. C | 52. C | 77. D |
| 3. C | 28. B | 53. D | 78. C |
| 4. E | 29. B | 54. E | 79. D |
| 5. B | 30. D | 55. B | 80. D |
| 6. D | 31. C | 56. B | 81. C |
| 7. E | 32. B | 57. B | 82. A |
| 8. B | 33. C | 58. E | 83. D |
| 9. D | 34. D | 59. A | 84. E |
| 10. E | 35. A | 60. D | 85. E |
| 11. B | 36. E | 61. C | 86. C |
| 12. D | 37. D | 62. E | 87. D |
| 13. A | 38. E | 63. D | 88. A |
| 14. D | 39. D | 64. C | 89. A |
| 15. C | 40. A | 65. D | 90. B |
| 16. C | 41. D | 66. E | 91. A |
| 17. C | 42. A | 67. A | 92. A |
| 18. D | 43. C | 68. D | 93. D |
| 19. B | 44. A | 69. B | 94. D |
| 20. A | 45. E | 70. B | 95. D |
| 21. B | 46. D | 71. B | 96. B |
| 22. C | 47. D | 72. C | 97. D |
| 23. A | 48. C | 73. D | 98. A |
| 24. C | 49. B | 74. C | 99. D |
| 25. C | 50. C | 75. B | 100. C |

PREDICT YOUR SCORE ON THE APES EXAM

Place a check mark (✓) next to the multiple-choice questions you got correct on page 444. Then fill in the blanks below to predict your overall score on the APES exam. Essay questions are not used in this prediction as they require subjective grading. You can also use this page to determine your areas of weakness. For example, if you got 5 out of 5 questions correct on The Earth, but only 2 out of 5 questions correct on the The Atmosphere, spend some more time reviewing The Atmosphere.

UNIT I: EARTH SYSTEMS AND RESOURCES (10%–15%)

Chapter 1: The Earth

(#2, 14, 23, 79, 94)

_____ correct/5 = ____%

Chapter 2: The Atmosphere

(#7, 36, 38, 44, 96)

_____ correct/5 = ____%

Chapter 3: Global Water Resources and Use

(#8, 39, 53, 68, 100)

_____ correct/5 = ____%

UNIT II: THE LIVING WORLD (10%–15%)

Chapter 4: Ecosystems

(#1, 15, 19, 22, 26, 27, 30, 31, 32, 33, 59, 60)

_____ correct/12 = ____%

Chapter 5: Natural Biogeochemical Cycles

(#5, 48, 92)

_____ correct/3 = ____%

UNIT III: POPULATIONS (10%–15%)

Chapter 6: Populations

(#29, 35, 57, 58, 65, 66, 67, 70, 85, 95)

_____ correct/10 = ____%

UNIT IV: LAND AND WATER USE (10%–15%)

Chapter 7: Land and Water Use

(#6, 11, 17, 25, 28, 40, 47, 51, 54, 61, 69, 72, 73, 76)

_____ correct/14 = ____%

UNIT V: ENERGY RESOURCES AND CONSUMPTION (10%–15%)

Chapter 8: Energy

(#24, 42, 43, 46, 55, 56, 63, 81, 82, 83)

_____ correct/10 = ____%

UNIT VI: POLLUTION (25%–30%)

Chapter 9: Pollution

(#9, 13, 16, 18, 20, 21, 37, 41, 45, 49,

50, 64, 74, 78, 84, 89, 97, 98)

_____ correct/18 = _____%

Chapter 10: Impacts on the Environment and Human Health

(#4, 12, 34, 52, 80, 93, 99)

_____ correct/7 = _____%

UNIT VII: GLOBAL CHANGE (10%–15%)

Chapter 11: Stratospheric Ozone and Global Warming

(#3, 10, 62, 71, 75, 77, 86, 87, 88, 90, 91)

_____ correct/11 = _____%

Total Number Correct

_____ / 100 = _____%

PREDICTED AP SCORE*

Less than 50 correct: 1 or 2 (not passing)

50–60 correct: 3 on the APES exam

61–75 correct: 4 on the APES exam

76+ correct: 5 on the APES exam

*Please note this is a rough estimate and is not intended to be an indicator of an actual AP score.

MULTIPLE-CHOICE EXPLANATIONS

1. **(C)** An increase in the population of squirrels would increase the competition for food and space.
2. **(D)** Approximately 3.5 billion years ago, the earliest life appeared on Earth from self-reproducing RNA molecules. DNA molecules eventually evolved inside enclosed membranes which provided a stable physical and chemical environment conducive for their replication.
3. **(C)** For (C) to be true, it would have read, "The Kyoto Protocol would have required the United States to *reduce* its greenhouse gas emissions—primarily carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O)—to 7% below 1990 levels by the year 2012."
4. **(E)** External costs are the costs that are borne by people other than the producer of a product.
5. **(B)** Ammonia is produced by the breakdown of organic sources of nitrogen when organisms die. Nitrification is the process by which this ammonia is converted to nitrites (NO₂⁻) by bacteria of the genus *Nitrosomonas* and then to nitrates (NO₃⁻) by bacteria of the genus *Nitrobacter*.
6. **(D)** Mitigation involves taking steps to lessen risk by lowering the probability of a risk event's occurrence or reducing its effect should it occur. Organizing a beach cleanup is remediation—reacting after the beach has been polluted.
7. **(E)** The easterly trade winds are driven by a surface pressure pattern of higher pressure in the eastern Pacific and lower pressure in the west. When this pressure gradient weakens, so do the trade winds. The weakened trade winds allow warmer water from the western Pacific to surge eastward leading to a buildup of warm surface water and a sinking of the thermocline in the eastern Pacific.
8. **(B)** Of the total freshwater on Earth, over 68% is locked up in ice and glaciers. However, as ice and glaciers melt, this number will change significantly. Another 30% of freshwater is in the ground. Rivers are the source of most of the fresh surface water people use, but they only constitute about 0.0002% of the total freshwater on Earth.
9. **(D)** About 38% of municipal solid waste (before recycling) by weight is paper and paper products. About 90% of paper is made of wood and accounts for about 35% of felled trees. Trees grown specifically for paper production account for 16% of all trees commercially grown and 9% of old growth forests. The manufacture and use of recycled paper products results in 35% less water pollution and 74% less air pollution than producing paper from trees.
10. **(E)** Sea levels are rising worldwide and are caused by both natural and human factors. It is predicted that within 100 years, there will be a net loss of 17%–43% of coastal wetlands due to rising sea levels.
11. **(B)** Ground fires generally kill large and small trees because of the long and high temperature heat pulse generated. They release considerable amounts of nutrients from the burned fuels, destroy many small organisms and fungi that live in the humus and organic layers, consume seed stored in the litter, and kill roots in all but deep soil layers.

They increase the chance of surface flow and erosion on slopes, and leave a baked and hardened seedbed that may prevent rapid revegetation. Increased surface runoff across the exposed surface may carry away ash and dissolved nutrients, making conditions even less favorable for plant growth.

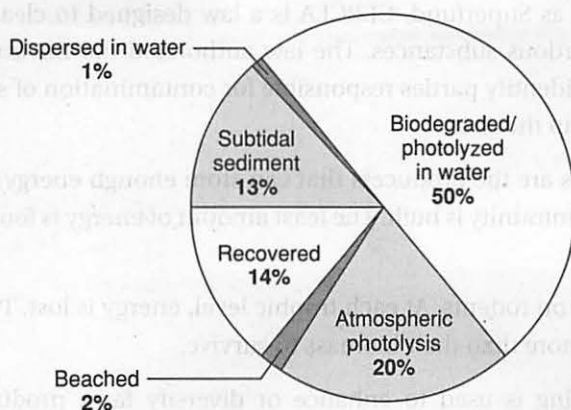
12. **(D)** Primary economic activities (III) are at the beginning of the production cycle where humans are in closest contact with resources and the environment. Primary economic activities are located at the site of the natural resources being exploited.

Secondary economic activities (I) use raw materials to produce or manufacture something new and more valuable. Examples of secondary activities include manufacturing, processing, producing power, and construction.

Tertiary economic activities (IV) include all activities that amount to doing services for others (e.g., doctors, clerks, restaurant and hotel staff, etc.).

Quaternary economic activities (II) are not connected to resources, access to a market, or the environment. Rather, they include professions that process, administer, and disseminate information (e.g., computer engineers, lawyers, etc. and loom large in highly advanced, developed societies).

13. **(A)** Plastic makes up 90% of all trash floating in the oceans, enough that, in some areas, plastic outweighs plankton by a ratio of 6 to 1. A circular pattern of currents, called the North Pacific Subtropical Gyre, has corralled an enormous vortex of floating garbage, often referred to as the Great Pacific Garbage Patch.
14. **(D)** Refer to Figure 1.3 (page 12).
15. **(C)** The release of carbon dioxide from coral reefs is very small (probably less than 100 million tons of carbon per year) relative to emissions due to fossil fuel combustion (about 5.7 billion tons of carbon per year). Coral reefs store very little organic carbon and are not very effective sinks for carbon dioxide from the atmosphere. Forests are more effective sinks for atmospheric carbon.
16. **(C)** Regulation is a command-and-control governmental approach that incurs costs to enact and enforce laws, set standards, regulate and monitor potentially harmful activities, and prosecute violators. Furthermore, regulation often focuses on cleanup instead of prevention, discourages innovation by mandating prescribed pollution control strategies, and is often unrealistic with the realities of a competitive global business environment.
17. **(C)** The Green Revolution refers to a series of research, development, and technology transfer initiatives, occurring between the 1940s and the late 1970s, that increased agriculture production around the world. The crops developed during the Green Revolution were high yield varieties, which were bred specifically to respond to fertilizers and produce an increased amount of grain per acre planted.
18. **(D)** Fifty percent of the spilled oil underwent biodegradation and photolysis (chemical decomposition). Cleanup crews recovered about 14% of the oil, and approximately 13% sunk to the seafloor. About 2% (some 216,000 gallons) remained on the beaches. Refer to the pie chart on page 449.

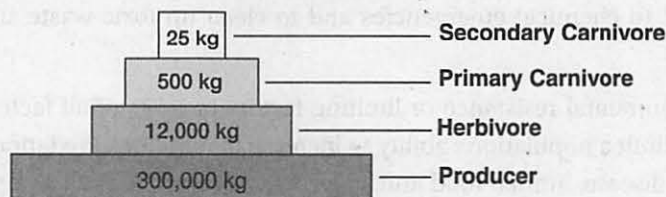


19. **(B)** Asexual reproduction produces organisms that are genetically identical to the parent. Fission is the simplest form of asexual reproduction and involves the division of a single organism into two complete organisms, each genetically identical to the other and to the parent (e.g., bacteria). Budding occurs when a group of self-supportive cells sprouts from and then detaches from the parent organism (e.g., hydra).
20. **(A)** The Resource Conservation and Recovery Act (RCRA) of 1976 addresses comprehensive management of nonhazardous and hazardous solid waste, sets minimal standards for all waste disposal facilities and for hazardous wastes, and regulates treatment, storage, and transport.
21. **(B)** In 1980, Congress passed the Superfund statute providing broad authorities both to respond to chemical emergencies and to clean up toxic waste sites for long-term protection.
22. **(C)** Environmental resistance or limiting factors consists of all factors in an environment that limit a population's ability to increase in numbers. Predation, competition for resources, disease, limited food and space, etc., all work to hold a population in check. Environmental resistance can be either density-dependent or density-independent. Factors that are density-dependent are stronger when a population has a higher density (more crowded). Examples would include predation, parasitism, disease, and competition for space or food. Density-independent factors (usually abiotic) will kill organisms—whether they are crowded or not. Examples would include floods, storms, earthquakes, fire, etc. In nature, biotic potential and environmental resistance work together to level out population numbers to an amount that can be supported by the environment. When environmental resistance “pushes down” on J curve growth, the curve levels into what is known as an S curve (or sigmoid curve) and reflects a balanced community.
23. **(A)** Refer to “Plate Tectonics” in Chapter 1.
24. **(C)** The emissions to the atmosphere from coal-burning power plants contain 84 of the 187 hazardous air pollutants posing a threat to human health and the environment. Coal-fired power plants in the United States account for 40% of all hazardous air pollutant point sources, more than any other point source category. Coal-burning power plants are the largest point source category for the release of hydrochloric acid, mercury, and arsenic and are a major source of several criteria air pollutants such as sulfur dioxide, oxides of nitrogen, and particulate matter.

25. **(C)** Also known as Superfund, CERCLA is a law designed to clean up sites contaminated with hazardous substances. The law authorized the Environmental Protection Agency (EPA) to identify parties responsible for contamination of sites and compel the parties to clean up the sites.
26. **(D)** Green plants are the producers that can store enough energy to provide the basis upon which a community is built. The least amount of energy is found at the level of the hawks.
27. **(C)** Snakes feed on rodents. At each trophic level, energy is lost. Therefore, the snakes must consume more than their biomass to survive.
28. **(B)** Alley cropping is used to enhance or diversify farm products, reduce surface water runoff and erosion, improve the utilization of nutrients, reduce wind erosion, modify the microclimate for improved crop production, and improve wildlife habitat. Hardwood trees, like walnut, oak, ash, and pecan, are favored species in alley cropping systems and can potentially provide high-value lumber.
29. **(B)** The population had grown by 1,300 (4,000 births – 3,000 deaths + 500 immigrants – 200 emigrants = 1,300).

$$\text{Net annual growth rate} = \frac{1,300}{100,000} \times 100\% = 1.3\%$$

30. **(D)** Less energy is available at each trophic level because energy is lost by organisms through respiration and incomplete digestion of food sources. Therefore, fewer herbivores can be supported by the vegetative material.



31. **(C)** Secondary consumers are carnivores that feed upon the flesh of other animals (e.g., a snake eating a rat).
32. **(B)** Both lizards and arachnids eat grasshoppers. Competition is the struggle between different species for the same resources.
33. **(C)** Saprophytic agents gain nourishment from dead organic matter, and they are the organisms of decay. Bacteria and fungi are saprophytes.
34. **(D)** When resources are scarce, the price goes up (law of supply and demand). The increase in prices causes people to conserve resources and use less because they are saving money.
35. **(A)** Diagram A, also known as an expansive pyramid, shows a broad base, indicating a high proportion of children, a rapid rate of population growth, and a low proportion of older people. A steady upward narrowing shows that more people die at each higher age band. This type of pyramid indicates a population in which there is a high birth rate, a high death rate, and a short life expectancy. This is the typical pattern for less economically-developed countries, due to little access to and incentive to use birth

control, negative environmental factors (e.g., lack of clean water), and poor access to health care.

36. **(E)** The thermohaline circulation plays an important role in supplying heat to the polar regions, and thus in regulating the amount of sea ice in these regions, although poleward heat transport outside the tropics is considerably larger in the atmosphere than in the ocean. Insofar as the thermohaline circulation governs the rate at which deep waters are exposed to the surface, it may also play an important role in determining the concentration of carbon dioxide in the atmosphere.
37. **(D)** Car A travels 500 miles at 15 miles to the gallon and therefore uses about $500/15 = 33.3$ gallons of gasoline. Car B travels the same 500 miles but uses about $500/30 = 16.7$ gallons of gasoline. Car A uses $33.3 - 16.7 = 16.6$ more gallons of gasoline than car B. If each gallon of gasoline that is burned contributes 5 pounds of carbon (in the form of CO_2) to the atmosphere, then car A will contribute $5 \times 16.6 = 83$ more pounds of carbon than car B.
38. **(E)** Earth is actually closest to the sun during the Northern Hemisphere winter.
39. **(D)** As the ocean warms, it expands and sea level rises, accounting for about one-third of the approximately 8 inches (20 cm) sea level rise seen in the past 100 years. Water released by melting glaciers and ice sheets accounts for the other two-thirds of sea level rise.
40. **(A)** Besides the effects already listed, additional effects include:
- Flattens the ocean bottom, filling in holes, leveling humps, and knocking down protruding organisms, all of which reduce biodiversity
 - Initiates erosion, causing long-term sedimentation problems
 - Changes the microhabitat, affecting primary productivity
 - Damages or kills both commercially harvested species and noncommercial species
 - Unlike clear-cutting in forests, the effects are not visible, thereby not getting much attention
41. **(D)** Pressure-treated wood contains arsenic, a highly toxic element, as well as chromium and copper. Dog and cat feces may carry diseases that can infect humans. Many types of weeds can resprout from their roots and/or stems in the compost pile. Bones (and the fat and marrow) are very attractive to pests such as rats. In addition, fatty food wastes can be very slow to break down because the fat can exclude the air that composting microbes need to do their work. Manure, which is defined as barnyard or stable dung often containing discarded animal bedding, typically contains large amounts of nitrogen (the fresher the manure, the more nitrogen it contains) and is considered a green ingredient.
42. **(A)** Sustainability is a concept long recognized and utilized by many cultures. It results from recognition of the need for a harmonious existence between the environment, society, and economy. Sustainability focuses on improving the quality of life for all people without increasing the use of natural resources beyond the capacity of the environment to supply them indefinitely.
43. **(C)** In a fossil fuel power plant, the chemical energy stored in chemical bonds in the fossil fuels (such as coal, fuel oil, or natural gas) and oxygen in the air is converted successively into thermal energy (heat), mechanical energy (spinning turbines), and finally electrical energy for continuous use and distribution across a wide geographic area.

Each of these processes is less than 100% efficient, with energy lost (usually as heat) at each stage.—The second law of thermodynamics states that the quality of a particular amount of energy—i.e., the amount of work or action that it can do—diminishes each time this energy is used and is true for all forms of energy (mechanical, chemical, etc.)

44. **(A)** In landmasses influenced by polar cells, temperature rather than precipitation is the critical factor in plant distribution and soil development. Landmasses in equatorial regions primarily influenced by Hadley cells are characterized by high humidity and lots of precipitation (e.g., tropical rainforests). Subtropical landmasses primarily influenced by Hadley cells are characterized by low relative humidity and deserts.
45. **(E)** Some of the hearing loss after exposure to excessive noise will be permanent. Indication of damage is ringing and noise in the ears (called tinnitus) after sound exposure. Research shows that cumulative exposure to loud sounds, not age, is the major cause of hearing loss.
46. **(D)** Enriched uranium is uranium whose uranium-235 content has been increased through the process of isotope separation. Enriched uranium is a critical component for both nuclear power generation (electricity) and military nuclear weapons.
47. **(D)** Integrated Pest Management (IPM) is a broad based ecological approach to agricultural pest control that integrates pesticides and herbicides into a management system incorporating a range of practices. In IPM, the purpose is to prevent infestation, to observe patterns of infestation when they occur, and to intervene (without poisons) when necessary.
48. **(C)** The primary source of CO_2 is outgassing from Earth's interior at mid-ocean ridges, hot-spot volcanoes, and volcanic arcs. Much of the CO_2 released at subduction zones is derived from the metamorphism of carbonate rocks subducting with the ocean crust. Much of the overall outgassing of CO_2 , especially at mid-ocean ridges and hot-spot volcanoes, was stored in the mantle when Earth formed. Some of the outgassed carbon remains as CO_2 in the atmosphere, some is dissolved in the oceans, some carbon is held as biomass in living or dead and decaying organisms, and some is bound in carbonate rocks.
49. **(B)** Peroxyacyl nitrates, or PANs, are powerful respiratory and eye irritants present in photochemical smog. PANs are both toxic and irritating, as they dissolve more readily in water than ozone. They cause eye irritation at concentrations of only a few parts per billion. At higher concentrations they cause extensive damage to vegetation. PANs are mutagenic and can be a factor that cause skin cancer. PANs are classified as secondary pollutants as they are not directly emitted as exhaust from power plants or internal-combustion engines, but they are formed from other pollutants by chemical reactions in the atmosphere. Since they dissociate quite slowly in the atmosphere, PANs are able to transport NO_x and other unstable compounds far away from their urban and industrial origins and form tropospheric ozone.
50. **(C)** Volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids with high vapor pressures (evaporate easily). Concentrations of many VOCs are often up to ten times higher indoors than outdoors. Examples of VOCs include paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, glues, and markers.

51. **(E)** See the table below.

Ocean	Amount of Fish Caught (Million tons)	% Fish Caught
Pacific	83	71
Atlantic	24	20
Indian	10	9
Southern (Antarctic)	0.147	0.1
Arctic	0	0
Overall	about 117	about 100%

52. **(C)** Salmon are inseparable from their freshwater, saltwater, and estuarine ecosystems. They are extremely sensitive to changes in water quality, changes in river flow, water turbidity, and temperature. Juvenile salmon feed on freshwater invertebrates that are also indicators of water quality. Generally, the more pristine, diverse, and productive the freshwater ecosystem is, the healthier the salmon stocks.
53. **(D)** Oligotrophic lakes contain very low concentrations of nutrients required for plant growth and thus the overall productivity of these lakes is low. Only a small quantity of organic matter is present (e.g., phytoplankton, zooplankton, algae, aquatic weeds, bacteria, and fish). With so little production of organic matter, there is very little accumulation of organic sediment on the bottom and the water is clear.
54. **(E)** (A) The National Park Service (Interior Department) provides for the use and enjoyment of the parks by people and preserves the land in its original state. (B) The Forest Service (Department of Agriculture) manages public lands in national forests and grasslands. (C) The Bureau of Land Management (Interior Department) manages range lands for grazing, oil and gas development, mining, and multiple-use resources such as wildlife, watersheds, recreation, and wilderness. (D) The Fish and Wildlife Service (Interior Department) administers a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States.
55. **(B)** All fluorescent lightbulbs contain mercury as vapor inside the glass tubing. Because mercury is poisonous, even these small amounts are a concern for landfills and waste incinerators where the mercury may be released and contribute to air and water pollution.
56. **(B)** The efficiency rating is calculated by comparing the amount of energy input to the amount of energy output (work accomplished). Efficiency is usually given as a percentage and can be computed with the following formula:

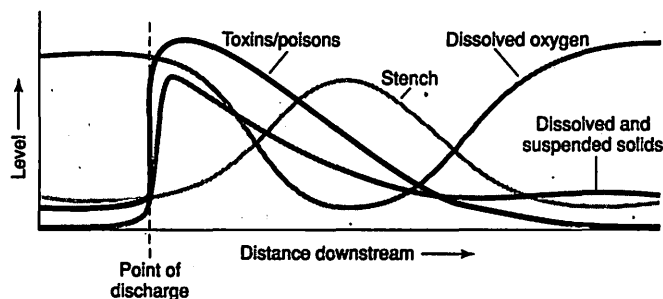
$$\frac{\text{Useful output}}{\text{Energy input}} = \text{efficiency rating (in decimal)}$$

$$\text{Useful output} = 10.0 \text{ joules} \times 0.10$$

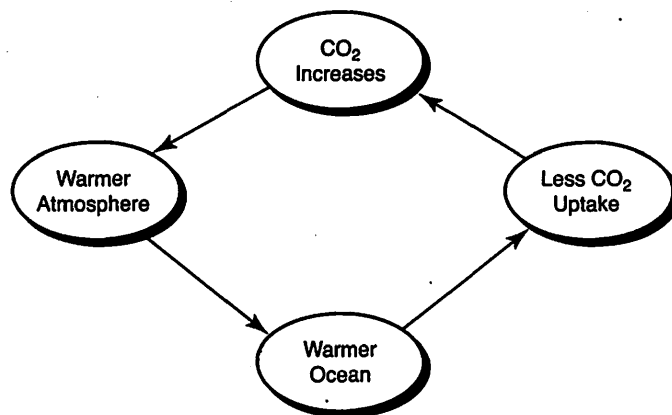
$$\text{Useful output} = 1 \text{ joule of light and therefore } 9 \text{ joules of heat energy (wasted)}$$

57. **(B)** The most probable explanation for the increase in the rabbit population after 1950 was that the coyote population declined drastically. The relationship indicated by the graph is one of predator-prey. The coyotes prey upon rabbits, keeping the population in check.

58. **(E)** The most probable explanation for the decline of the coyotes is removal by humans. Since the decline in coyotes occurred with cattle introduction and since cattle and coyotes do not compete for the same food, the individuals that introduced the cattle must have interfered with the coyote population. Because coyotes are predators, they were likely perceived as dangerous to the cattle and were likely hunted and poisoned by humans. Attempts to control coyotes by poisoning may deplete the numbers of their natural prey and lead to increasing attacks by coyotes on farm animals.
59. **(A)** Savannas are warm year-round with a prolonged dry season and scattered trees. The environment is intermediate between grassland and forest. Savannas consist of grasslands with stands of deciduous shrubs and trees that do not grow more than 30 meters high. Trees and shrubs generally shed leaves during the dry season, which reduces the need for water. Food is limited during the dry season so that many animals migrate during this season. Soils are rich in nutrients. Savannas contain large herds of grazing animals and browsing animals that provide resources for predators.
60. **(D)** The tundra is located at 60° north latitude and farther north, and the weather is influenced by the polar cell. Arctic tundra is frozen treeless plains, low rainfall, low average temperatures (summers average $<10^\circ\text{C}$), and many bogs and ponds.
61. **(C)** Selective cutting is used for the majority of shade-tolerant hardwood forests. About every 20 to 30 years, individual mature and declining (diseased or unhealthy) trees are cut. The growth rate and quality of the remaining trees improves, and young trees of the shade-tolerant species become established in the mostly-shaded understory. Selective cutting imitates minor natural disturbances like wind and disease and perpetuates an all-aged tolerant hardwood forest.
62. **(E)** Swamps and marshes are the most productive biomes, producing the most biomass per year, while tropical rainforests have the most standing biomass. Extreme deserts are the least-productive biomes.
63. **(D)** The boiling point of a crude oil component or fraction, which is the temperature at which it evaporates, is dependent on the length of the carbon chain in the molecule. Those fractions with shorter chains (such as gasoline) evaporate more easily than those with longer chains (such as waxes).
64. **(C)** At the point of discharge, there is a sudden increase in the amount of toxins, suspended solids, and dissolved organic compounds. The water becomes unsuitable for any human use. Aerobic bacteria increase rapidly, reducing the organic pollutants but using up dissolved oxygen. As the oxygen level falls, anaerobic bacteria multiply, resulting in an unpleasant smell or stench. Eventually, as their food supply is used up, the decomposers reduce and algae thrive, reoxygenating the water. Fish and other animal life reappear, and the stream returns to its previous condition.

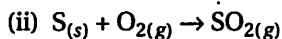
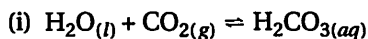


65. **(D)** Thomas Malthus recognized that once the carrying capacity of an area was exceeded, organisms would die of starvation. Darwin's theory of evolution based on natural selection may have been influenced by Malthus's concept.
66. **(E)** Note that only 10% of the population of young oysters reaches the 20th unit of life span.
67. **(A)** Note that almost all of the fruit flies reach the 90th unit of life span before the entire population dies.
68. **(D)** In the normal resting state for an adult human, the input of water through ingested fluids is approximately 1,200 ml/day, from ingested foods about 1,000 ml/day, and from aerobic respiration about 300 ml/day, totaling about 2,500 ml (about 0.5 gallons)/day. To make up for this deficit, the average requirement for drinking water per person per day is approximately 0.5 gallons.
69. **(B)** In IPM, one attempts to prevent infestation to observe patterns of infestation when they occur and to intervene when necessary. Synthetic pesticides are generally only used as required and only at specific times in a pest's life cycle.
70. **(B)** To calculate doubling time, divide the growth rate into the number 70. Thus a growth rate of 2% (0.02) will cause a population to double in number in 35 years ($70 \div 2 = 35$). $2010 + 35 \text{ years} = 2045$.
71. **(B)** $350 - 250 = 100$ $100/250 = 0.40$ $0.40 \times 100\% = 40\%$
72. **(C)** Drylands occupy approximately 40% of Earth's land area and are home to more than 2 billion people, and it has been estimated that some 10%–20% of drylands are already degraded. Desertification is the degradation of land in any dryland. It is caused by a variety of factors, such as climate change and human activities. The most common cause of desertification is the overcultivation of desert lands which causes the nutrients in the soil to be depleted faster than they are restored. Furthermore, improper irrigation practices result in salinated soils and the depletion of aquifers.
73. **(D)** A pure capitalistic economy, in which financial gain is the primary societal motivator, leads to "taking just one more."
74. **(C)** Industrial wastes of unknown content are often commingled with domestic wastes in sanitary landfills. Groundwater infiltration and contamination of water supplies with toxic chemicals have recently led to more active control of landfills and industrial waste disposal. Careful management of sanitary landfills, such as providing for leachate and runoff treatment as well as daily coverage with topsoil, has stopped most of the problems of open dumping. In many areas, however, space for landfills is running out, and alternatives must be found.
75. **(B)** The oceans are an important sink for CO_2 through absorption of the gas into the water surface. As atmospheric CO_2 levels increase, it increases the warming potential of the atmosphere, a process called global warming. If air temperatures warm, they increase ocean temperatures. However, the ability of the ocean to remove CO_2 from the atmosphere decreases with increasing ocean temperatures based on principles of solubility.

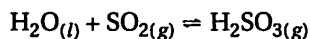


76. **(B)** The slope of the dose-response curves gives a good indication of how a target population will respond to the pesticide. If some members of the population are much more sensitive to the pesticide than others, the population is said to be more heterogeneous or diverse and tends to survive better through natural selection in a changing environment.
77. **(D)** The depth at which plankton can exist depends on the penetration of sunlight, which provides the energy for photosynthesis. Since the phytoplankton is abundant near the surface, the region of sunlight penetration, the consumers are also found in this region.
78. **(C)** A point source of pollution is a single, identifiable, localized source of air, water, thermal, or noise or light pollution and is generally considered to be fixed (immobile).
79. **(D)** Shield volcanoes are built almost entirely of fluid lava flows in which flow after flow pours out in all directions from a central summit vent, or group of vents, building a broad, gently sloping cone with a flat, domed shape. They are built up slowly by the accumulation of thousands of flows of highly fluid basaltic lava that spread widely over great distances and then cool as thin, gently dipping sheets. Examples of shield volcanoes include those found in the Hawaiian Island chain, the Galapagos Islands, Iceland, and East Africa.
80. **(D)** More preventable deaths in the United States are caused each year by tobacco use than by all deaths from AIDS, illegal drug use, alcohol use, motor vehicle injuries, suicides, and murders combined; however, obesity and its effects are dramatically increasing. Cigarette smoking causes about 1 of every 5 deaths in the United States each year.
81. **(C)** Countries in the Middle East own 56% of the world's proven oil reserves.
82. **(A)** Coal provides 44% of the world's electricity and 27% of its overall energy. The United States still has the world's largest coal reserves with approximately one-quarter of the total (28%). Existing supplies are estimated to last for almost 200 years at current rates of consumption.
83. **(D)** As of 2016, proven gas reserves are dominated by three countries: Iran (18%), Russian Federation (17%), and Qatar (13%). The United States has 6% of the world's total.

84. **(E)** Chemical formulas involved in producing acid rain include:



The $\text{SO}_{2(g)}$ combines with water to produce sulfurous acid:

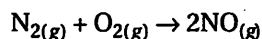


Sulfur dioxide, however, is not readily oxidized to sulfur trioxide in dry, clean air. Water droplets and dust particles, however, catalyze the reaction between O_2 and SO_2 in the air producing sulfur trioxide, SO_3 which dissolves in water to produce sulfuric acid, which is a much stronger acid:

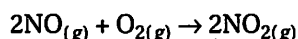


This can cause considerable damage to buildings, vegetation, and fish populations by destroying fish eggs.

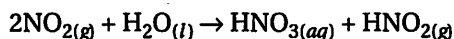
(iii) Sources of NO_x are more widespread. At temperatures over $2,370^\circ\text{F}$ ($1,300^\circ\text{C}$), nitrogen combines with oxygen to form nitrogen monoxide:



These high temperatures can be achieved by: (i) the internal-combustion engine; and (ii) lightning in the atmosphere. The nitrogen monoxide slowly combines with oxygen to form soluble nitrogen dioxide gas:



Nitrogen dioxide readily dissolves in water, producing a mixture of nitric and nitrous acids:



85. **(E)** Between 1999 and the start of 2012 when the world's population increased from 6 billion to 7 billion people, the Asian population, which represents 60% of the current world population, grew by an estimated 579 million people making up about 57% of that increase. The African population meanwhile contributed 28% to the population increase.

86. **(C)** From a population of tens of thousands in the 19th century, the bald eagle had declined to only 417 pairs in the lower 48 states by 1963. By 2006, after 32 years of protection through the Endangered Species Act, the population had grown to almost 10,000 breeding pairs.

87. **(D)** Feedback loops can enhance or buffer changes that occur in a system. Positive feedback loops enhance or amplify changes and tend to move a system away from its equilibrium state and make it more unstable (i.e., a change [increase or decrease] in some variable results in the same type of change [increase or decrease] in a second variable). Negative feedback loops tend to dampen or buffer changes, which tends to hold a system to some equilibrium state, making it more stable.

88. **(A)** Nonanthropogenic means not caused by humans. When the choices are ranked by their contribution to the greenhouse effect, they are: (1) water vapor; (2) carbon dioxide; (3) methane; and (4) tropospheric ozone. Nitrogen is not a greenhouse gas.
89. **(A)** Eighty percent of pollution in the marine environment comes from the land. One of the biggest sources is nonpoint source pollution with storm water runoff serving as the largest contributor.
90. **(B)** Currently, atmospheric carbon dioxide levels are 25% above where they stood at the time of the Industrial Revolution.
91. **(A)** $\% \text{ change} = ((\text{new value} - \text{original value}) \div \text{original value}) \times 100$
92. **(A)** Phosphorus normally occurs in nature as a phosphate ion; the most abundant form is called orthophosphate, PO_4^{3-} . Most phosphates are found as salts in ocean sediments or in rocks. Over time, geologic processes can bring ocean sediments to land, and weathering will carry terrestrial phosphates back to the ocean.
93. **(D)** The median lethal dose, LD_{50} of a toxin, radiation, or pathogen is the dose required to kill half the members of a tested population after a specified test duration. LD_{50} figures are frequently used as a general indicator of a substance's acute toxicity.
94. **(D)** In (A) activity is low, and it occurs at very shallow depths. The point is that the lithosphere is very thin and weak at these boundaries, so the strain cannot build up enough to cause large earthquakes. The San Andreas fault is a good example of (B) in which two mature plates are scraping by one another. The friction between the plates can be so great that very large strains can build up before they are periodically relieved by large earthquakes. In (C) one plate is thrust or subducted under the other plate so that a deep ocean trench is produced. In (E) shallow earthquakes are associated with high mountain ranges where intense compression is taking place. In (D) the interiors of the plates themselves are largely free of large earthquakes, that is, they are aseismic.
95. **(D)** In stage three of the demographic stage model, birth rates fall due to access to contraception, resulting in smaller family sizes, increases in wages, urbanization, a reduction in subsistence agriculture, an increase in the status and education of women, a reduction in the value of children's work, an increase in parental investment in the education of children, and other social changes. Although birth rates are declining, the population is still increasing. The death rate continues to fall from stage two due to greater access to health care, smaller family sizes, and lower childhood mortality rates. Examples of countries in stage three include Mexico, the Philippines, Indonesia, and India.
96. **(B)** Differences in air pressure help cause winds and affect air masses. They are also factors in the formation of storms such as thunderstorms, tornadoes, and hurricanes. Differences in air pressure are shown on a weather map with lines called isobars. The weather map illustrates isobars marking areas of high and low pressure. High-pressure areas generally have dry, good weather, and areas of low pressure have precipitation. On this weather map, the only area of low pressure is centered in the Midwest.
97. **(D)** The pH scale is logarithmic, and as a result, each whole pH value below 7 is ten times more acidic than the next higher value.

98. **(A)** SBS (sick-building syndrome) is associated with acute or immediate health problems. Radon and asbestos cause long-term diseases that occur years after exposure and are therefore not considered to be among the causes of sick buildings.
99. **(D)** Tropospheric ozone would be ozone found in the air that we breathe, generally produced by burning fossil fuels. No relationship has been found that skin cancer is increased by decreases in smog.
100. **(C)** Agriculture accounts for 92% of all freshwater use globally. China, India, and the United States are responsible for nearly 38% of global water consumption. The United States leads the world in per capita consumption of freshwater: 751,000 gallons (2,842 m³) each year, compared with the global average of 366,000 gallons (1,385 m³) per year.

FREE-RESPONSE EXPLANATIONS

Question 1

10 Total Points Possible

(a) 5 points maximum

Calculate the total amount of energy (in Btu) to wash the clothes using the washing machine.

Mass of water:

$$20 \text{ gallons H}_2\text{O} \times \frac{8 \text{ pounds}}{1 \text{ gallon H}_2\text{O}} = 160 \text{ pounds H}_2\text{O} \quad (1 \text{ point})$$

Energy to heat water:

$$160 \text{ pounds H}_2\text{O} \times \frac{1 \text{ Btu/}^\circ\text{F}}{1 \text{ pound H}_2\text{O}} \times (130^\circ\text{F} - 60^\circ\text{F}) = 11,200 \text{ Btu} \quad (1 \text{ point})$$

Energy to run washing machine (kWh):

$$1,500 \text{ watts} \times \frac{1 \text{ kW}}{1,000 \text{ watts}} \times 30 \text{ min} \times \frac{1 \text{ hr}}{60 \text{ min}} = 0.75 \text{ kWh} \quad (1 \text{ point})$$

Energy to run washing machine (Btu):

$$0.75 \text{ kWh} \times \frac{3,400 \text{ Btu}}{1 \text{ kWh}} = 2,550 \text{ Btu} \quad (1 \text{ point})$$

Total energy for washing machine:

$$11,200 \text{ Btu} + 2,550 \text{ Btu} = 13,750 \text{ Btu} \quad (1 \text{ point})$$

(b) 2 points maximum

Calculate the total amount of energy (in Btu) to wash the clothes by hand.

$$35 \text{ gallons H}_2\text{O} \times \frac{8 \text{ pounds}}{1 \text{ gallon H}_2\text{O}} = 280 \text{ pounds H}_2\text{O} \quad (1 \text{ point})$$

Energy to heat water:

$$280 \text{ pounds H}_2\text{O} \times \frac{1 \text{ Btu/}^\circ\text{F}}{1 \text{ pound H}_2\text{O}} \times (130^\circ\text{F} - 60^\circ\text{F}) = 19,600 \text{ Btu} \quad (1 \text{ point})$$

NOTE:

1. If you do NOT show calculations, no points are awarded.
2. No penalty will be assessed if you do not show units. However, you risk setting up the problem incorrectly if you do not show units so that they cancel properly.
3. If your setup is correct but you make an arithmetic error, there is no penalty.

(c) 3 points maximum

NOTE: There are no points for just listing ideas. Each idea **MUST** be explained. The following are ideas that you could use to write your paragraph(s). Take these ideas and create an outline of the order in which you wish to answer them. You do NOT need to use all ideas. Before you begin, decide on the format of how you wish to answer your question (pros versus cons, chart format with explanations within the chart, compare and contrast, etc.).

- (i) *Discuss the economic and environmental costs and benefits of using a washing machine in terms of its manufacture and disposal. (1 point)*
- Manufacturing washing machines provides jobs in mining, smelting, designing, engineering, manufacturing, transportation, administration, advertising, repair, and sales.
 - Use of natural resources in the manufacture and distribution of washing machines. Examples: use of renewable or less polluting energy sources in manufacturing; use of less polluting methods of transportation.
 - Advantages of repairing washing machines rather than discarding them. Discarding them creates landfill issues. Recycling of metal parts and packaging material saves energy and decreases landfill issues.
- (ii) *Discuss the economic and environmental costs and benefits of using a washing machine in terms of selecting one and purchasing it (specifically, how can consumers compare various appliances in terms of their energy use). (1 point)*
- Energy efficiency of different models. The U.S. Department of Energy and the U.S. Protection Agency have joined with appliance manufacturers to institute the "Energy Star®" program. Appliances displaying an Energy Star® label have been certified to significantly exceed the federal efficiency standards.

- Choosing a machine that uses the fewest gallons of water per pound of clothes and one that has high, medium, and low water level controls and an automatic cold rinse cycle.
- Consider high efficiency (HE) washing machines. Advantages of HE washing machines include:
 - A traditional washing machine will use 40 to 47 gallons (151 to 178 L) of water per cycle, while high efficiency washing machines use 11 to 32 gallons (42 to 121 L) of water per cycle.
 - Energy savings with high efficiency washers are estimated at 50% to 60% per each load. Much of the energy savings afforded by high efficiency washing machines are a result of the significant reduction in the hot water they require.
 - The horizontal drums utilized in a high efficiency washing machine spin at a much faster rate than other machines. This allows more water to be extracted from the clothes during the spin cycle. Consequently, clothes contain less moisture at the end of the wash and require less time and energy to dry.
 - A high efficiency washing machine will use two to four clean rinses per cycle, reducing levels of detergent residue left on clothing as well as improving cleaning efficiency by not having clothes sitting in dirty water.
 - The tumbling motion in a high efficiency washing machine causes clothes to circulate freely resulting in a more effective cleaning process and creates less wear and tear on garments. The tumble motion is gentler with less stress and pulling on fabric than the agitation motion.
 - Tumbling and increased circulation of items in the drum requires that a high efficiency detergent be used in these machines. High efficiency detergents have fewer suds, requiring less water to then rinse away.

(iii) *Discuss the economic and environmental costs and benefits of using a washing machine in terms of steps consumers can take to reduce its environmental impact. (1 point)*

- Use appliances during off-peak hours
- Use biodegradable detergents that use minimal amounts of phosphates
- Pre-soak heavily soiled clothes
- Try to use only with full loads
- Use as low a water temperature for the washing cycle as will provide satisfactory results
- Always use a cold rinse cycle
- Follow the maintenance schedule and instructions found in the owner's manual

Question 2

10 Total Points Possible

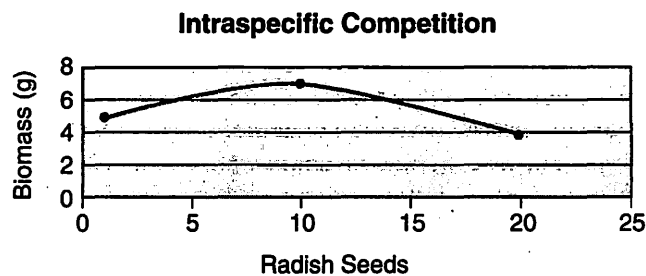
(a) 5 points maximum

(i) At what population density was the biomass per plant highest? (1 point)

To determine the optimum population density that produced the greatest biomass would require *dividing the total biomass for each planting by the total amount of seeds planted per pot*. This would provide the average biomass and produce the following results:

Seeds per Pot	Average Biomass (g)
1	5.0
10	7.0
20	3.8

From the data table, it appears that *10 radish seeds per pot produced the largest average biomass*. When graphed, the results look like:



(ii) Identify and describe TWO resources that may have been limited. (2 points)

The maximum biomass was achieved at 10 seeds per pot. After that, as population density increased, biomass decreased. Factors that may have limited biomass might have included:

1. *Competition for soil nutrients.* As root density increased, less nutrients would have been available for growth.
2. *Competition for light.* As the density increased, less light would have been available for smaller seedlings.
3. *Competition for water.* Given a fixed amount of water provided, as plant density increased, less water would have been available for additional seedlings.

(iii) Discuss the results obtained from the class for Part I in terms of two biological laws or principles. (2 points)

The effect of intraspecific competition in plant populations is usually examined by planting the species over a range of densities. The most common result is that a point is reached where the mean weight per plant decreases as density increases, so that the maximum yield approaches some constant value. This result is called the *law of constant yield*. The maximum plant productivity of a particular environment is called the carrying capacity. In this case, the carrying capacity was reached when the biomass reached 7.0 grams for the size of the pot. Environmental variables (nutrients, space, water, and light) that restrict the realized niche are called limiting factors. *Liebig's law of the minimum* states that an organism is most limited by the essential factor that is in least supply. In terms of survivorship, the radish seeds represent Type III characteristics that include large amounts of seeds being produced with few surviving, small size invaders of disturbed environments, and rapid growth.

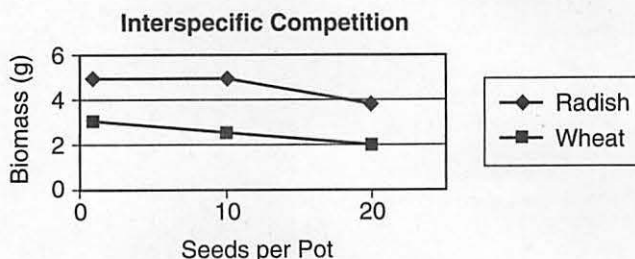
(b) 5 points maximum

(i) Which plant was most affected by the competition between the two species? (1 point)

To determine which plant species was most negatively affected by interspecific competition would require dividing the total biomass per pot by the total number of seeds per pot to determine average biomass. The results are provided below:

Seeds per Pot	Average Biomass (g)
1 radish	5.0
1 wheat	3.0
10 radish	5.0
10 wheat	2.5
20 radish	3.8
20 wheat	2.0

From the table, it appears that the wheat seedlings were negatively impacted by the presence of the radish seeds. When graphed, the results are:



(ii) Describe TWO possible reasons why the plant chosen in (i) may have been more successful. (2 points)

Two different species of plants were grown in the same medium. Nutrient requirements may have been different between the two species. For example, the amount and ratios of minerals contained in the potting soil may have met the metabolic requirements of the radish plants more than the wheat seedlings. Water and light availability (either too much or too little) may also have affected the outcome. Differences in growth patterns (radish may sprout earlier than wheat) may have existed. In this case, the radish seedlings may have sprouted earlier and established a population that was taking up a fixed amount of nutrients at a faster rate or had established a canopy that decreased the light available for the wheat seedlings. Simultaneous to the interspecific competition was intraspecific competition. Not only were radish seedlings in competition with wheat seedlings, but they were also in competition with other radish seedlings for limited nutrients.

(iii) Discuss the results obtained from the class for Part II in terms of two biological laws or principles. (2 points)

In Part II, plant density was held constant in a substitutive or replacement experimental design in which the total density of both species was kept constant while the relative densities were varied (1, 10, and 20). This approach allows for the investigation of the effects of interspecific competition from the effects of increasing overall plant density on growth or production of a species. However, it requires first quantifying the background effect of intraspecific competition on the growth of each species individually. Such an experiment has three possible outcomes. First, one species prospers at the expense of the other (competitive exclusion). Second, one species outperforms the other but only when in higher proportion (coexistence). Third, the two species have no measurable effect on each other (no competition). The latter would be the null hypothesis (H_0) by which the class would judge whether or not one of the other two scenarios happened. Another scenario, which was not tested for, could have been instability—that is, two species are in a constant state of dynamic tension where at one time one species dominates and at other times the other species dominates. Different species of plants are able to coexist within the same biome through resource partitioning, which functions through the evolution of different metabolic pathways, having different tolerances to shade, taking up water and nutrients at different depths, etc.

Question 3

10 Total Points Possible

(a) 4 points maximum

Compare and contrast the two age-structure diagrams in terms of two population dynamics—birth rate and death rate.

Age-structure diagrams are basically divided into three major age categories:

- Pre-reproductive (0–15 years old)
- Reproductive (16–45 years old)
- Post-reproductive (46 years old–death)

Population Characteristics

	Affected by	Sweden	Kenya
Birth Rate	<ul style="list-style-type: none"> ■ Importance of children as a part of the labor force ■ Urbanization ■ Cost of raising and educating children ■ Educational and employment opportunities for women ■ Infant mortality rate ■ Average age at marriage ■ Pensions ■ Abortions ■ Birth control ■ Religious beliefs 	<ul style="list-style-type: none"> ■ Population has nearly equal proportions of pre-reproductive and reproductive individuals. ■ Little growth over a long period of time will produce a population with about equal numbers of people in all age groups. ■ Children not required or necessary to support parents. ■ Availability and acceptance of birth control. 	<ul style="list-style-type: none"> ■ Population has pyramid-shaped age structures, with large numbers of pre-reproductive individuals. ■ Population momentum results from large numbers of pre-reproductive children becoming reproductive within a short period of time. ■ High population rate due to high birth mortality rates. ■ Children viewed as status symbol. ■ Resistance to birth control.
Death Rate	<ul style="list-style-type: none"> ■ Increased food supply ■ Better nutrition ■ Improved medical and public health technology ■ Improvements in sanitation and personal hygiene ■ Safer water supplies 	<ul style="list-style-type: none"> ■ Elderly survive longer due to advances in medical technology and availability. ■ Social welfare programs ensure that the elderly are taken care of. 	<ul style="list-style-type: none"> ■ Elderly do not survive due to lack of available medical technology. ■ Disease (for example, malaria or AIDS) and lack of nutritious food decreases life span.

(b) 4 points maximum

What factors affect both birth rates and death rates?

List any four characteristics from the column labeled "Affected By" on the table on page 465.

(c) 2 points maximum

Discuss methods that have been employed by another country to curb population growth.

List any two of the six methods mentioned below.

China: Between 1958 and 1962, an estimated 30 million people died from famine in China. Since then, China has made good progress in trying to feed its people and bring its population growth under control. Much of this reduced population growth was brought about by a drop in the birth rate from 32 to 18 per 1,000 between 1972 and 1985. China instituted one of the most rigorous population control programs in the world at an estimated cost of about \$1 per person. Some features of the program during that time included:

1. Strong encouragement for couples to postpone marriage.
2. Providing married couples with free access to sterilization, contraceptives, and abortion.
3. Giving couples who signed pledges to have no more than one child economic rewards such as salary bonuses, extra food, larger pensions, better housing, free medical care and school tuition for their child, and preferential treatment in employment when the child grows up.
4. Requiring those who broke the pledge to return all benefits.
5. Exerting pressure on women pregnant with a third child to have abortions.
6. Requiring one of the parents in a two-child family to be sterilized.

However, as of 2017, the Chinese government is considering giving families financial incentives to have a second child in an effort to reach higher birth rate targets. This change is due in part to: (1) over half of Chinese families being reluctant to have a second child because of financial constraints; (2) an aging population and workforce; and (3) a disproportionate ratio of males to females.

Question 4

10 Total Points Possible

(a) 7 points maximum

Explain what a pesticide is. (1 point maximum for correct explanation)

A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. Pests can be insects, rodents or other animals, unwanted plants (weeds), fungi, or microorganisms such as bacteria or viruses.

(i) Describe TWO major categories of pesticides. For example: Insecticide—kills insects and other arthropods. (Do NOT use insecticide as one of your categories.) (2 points maximum. 1 point for each correct category of pesticide and description.)

Algicides	Control algae in lakes, canals, swimming pools, water tanks, and other sites.
Antifouling agents	Kill or repel organisms that attach to underwater surfaces, such as boat bottoms.
Antimicrobials	Kill microorganisms (such as bacteria and viruses).
Attractants	Attract pests (for example, to lure an insect or rodent to a trap). Food is not considered a pesticide when used as an attractant.
Biocides	Kill microorganisms.
Defoliants	Cause leaves or other foliage to drop from a plant, usually to facilitate a harvest.
Desiccants	Promote drying of living tissues, such as unwanted plant tops.
Disinfectants and sanitizers	Kill or inactivate disease-producing microorganisms on inanimate objects.
Fungicides	Kill fungi (including blights, mildews, molds, and rusts).
Fumigants	Produce gas or vapor intended to destroy pests in buildings or soil.
Herbicides	Kill weeds and other plants that grow where they are not wanted.
Insect growth regulators	Disrupt the molting, maturing from pupal stage to adult, or other life processes of insects.
Miticides (acaricides)	Kill mites that feed on plants and animals.

Microbial pesticides	Microorganisms that kill, inhibit, or outcompete pests, including insects or other microorganisms.
Molluscicides	Kill snails and slugs.
Nematicides	Kill nematodes (microscopic, wormlike organisms that feed on plant roots).
Ovicides	Kill eggs of insects and mites.
Pheromones	Biochemicals used to disrupt the mating behavior of insects.
Plant growth regulators	Substances (excluding fertilizers or other plant nutrients) that alter the expected growth, flowering, or reproduction rate of plants.
Repellents	Repel pests, including insects (such as mosquitoes) and birds.
Rodenticides	Control rats, mice, and other rodents.

(ii) *Identify and discuss TWO positive effects of pesticide use. (2 points maximum. 1 point for each correct positive effect and explanation.)*

- (1) Plants are directly and indirectly humankind's main source of food. They are attacked by tens of thousands of diseases caused by viruses, bacteria, fungi, and other organisms. There are over 30,000 kinds of weeds competing with crops worldwide. Thousands of nematode species reduce crop vigor, and some 10,000 species of insects devour crops. It is estimated that one-third of the world's food crop is destroyed by these pests annually. Pesticides increase the world food supply.
- (2) There are an estimated 300–500 million cases of malaria per year. The majority of these occur in Africa. The vast majority of the estimated 1 million annual deaths from this disease occur among children and mainly among poor African children. Malaria is often a disease of the poor, impacting at least three times more greatly on the poor than any other disease. Africa's GDP would be up to \$100 billion greater if malaria had been eliminated years ago. Mosquitoes have been estimated to be responsible for half of all human deaths due to transmission of disease. Pesticides improve human health by destroying disease-carrying organisms.

(iii) *Identify and discuss TWO negative effects of pesticide use. (2 points maximum. 1 point for each correct negative effect and explanation.)*

- (1) If a pesticide is continually applied to a population of the pest species, most susceptible individuals will be killed, leaving only resistant individuals. These resistant individuals breed and multiply. Eventually a high proportion of the individuals from that pest species are now resistant to the pesticide. We have simply caused pest populations with a higher tolerance for poisons to survive and breed. More toxic pesticides in turn are developed and utilized.
- (2) Pesticides can accumulate in living organisms. An example of accumulation is the uptake of a water-insoluble pesticide, such as chlordane, by a creature living in water. Since this pesticide is stored in the organism, the pesticide accumulates and increases over time. If this organism is eaten by an organism higher in the food chain that can also store this pesticide, levels can reach higher values in the higher organism than is present in the water in which it lives. Levels in fish, for example, can be tens to hundreds of thousands of times greater than ambient water levels of the same pesticide. This type of accumulation is called bioaccumulation. In this regard, it should be remembered that humans are at the top of the food chain and so may be the most vulnerable to bioaccumulation.

(b) *Discuss any TWO alternatives to the use of pesticides. (2 points maximum. 1 point for each correct alternative and explanation.)*

- (1) When landscaping a yard or planning a garden, choose plant varieties that are native to the region and climate. Hardy, native plants resist disease and infestation, and they often use less water.
- (2) Plant rotation and interplanting prevent the buildup and spread of pests in one area or among specific plant types.
- (3) Protect and encourage the presence of insect-feeding birds, bats, spiders, praying mantises, ladybugs, predatory mites, parasitic flies, and wasps. Beneficial insect species can often be purchased in volume.
- (4) Pheromones are chemical signals produced by animals to communicate with others of the same species. In insects, they consist of highly specific perfumes, generally derivatives of natural fatty acids closely related to the aromas of fruit. They are nontoxic. Pheromones may be used to attract insects to traps or to deter insects from laying eggs. However, the most widespread and effective application of pheromones is for mating disruption.

(c) Name and describe ONE U.S. federal law OR ONE international treaty that focuses on the use of pesticides. (1 point for naming a correct U.S. federal law or international treaty along with a correct description.) Note: Credit will be awarded for choosing any applicable U.S. federal law or international treaty that focuses on the use of pesticides (e.g., Clean Water Act; Resource Conservation and Recovery Act; Comprehensive Environmental Response, Compensation, and Liability Act (Superfund); etc.)

The U.S. federal government first regulated pesticides when Congress passed the Insecticide Act of 1910. This law was intended to protect farmers from adulterated or misbranded products. Congress broadened the federal government's control of pesticides by passing the original Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) of 1947. FIFRA required the Department of Agriculture to register all pesticides prior to their introduction in interstate commerce. A 1964 amendment authorized the Secretary of Agriculture to refuse registration to pesticides that were unsafe or ineffective and to remove them from the market. In 1970, Congress transferred the administration of FIFRA to the newly created Environmental Protection Agency (EPA). This was the initiation of a shift in the focus of federal policy from the control of pesticides for reasonably safe use in agricultural production to the control of pesticides for reduction of unreasonable risks to humans and the environment. This new policy focus was expanded by the passage of the Federal Environmental Pesticide Control Act of 1972 (FEPCA) that amended FIFRA by specifying methods and standards of control in greater detail. In general, there has been a shift toward greater emphasis on minimizing risks associated with toxicity and environmental degradation and away from pesticide efficacy issues. Under FIFRA, no one may sell, distribute, or use a pesticide unless it is registered by the EPA. Registration includes approval of the pesticide's label by the EPA. The label must give detailed instructions for its safe use. The EPA must classify each pesticide as either general use, restricted-use, or both. General-use pesticides may be applied by anyone. However, restricted-use pesticides may be applied only by certified applicators or persons working under the direct supervision of a certified applicator. Because there are only limited data for new chemicals, most pesticides are initially classified as restricted-use. Applicators are certified by a state if the state operates a certification program approved by the EPA.