2003

The Exam

ENVIRONMENTAL SCIENCE

Three hours are allotted for this examination: 1 hour and 30 minutes for Section I, which consists of multiple-choice questions; and 1 hour and 30 minutes for Section II, which consists of essay questions. Section I is printed in this examination booklet. Section II is printed in a separate booklet.

SECTION I

Time — 1 hour and 30 minutes

Number of questions — 100

Percent of total grade — 60

Section I of this examination contains 100 multiple-choice questions and 9 survey questions. Therefore, please be careful to fill in only the ovals that are preceded by numbers 1 through 109 on your answer sheet. No calculators may be used on this examination.

General Instructions

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

INDICATE ALL YOUR ANSWERS TO QUESTIONS IN SECTION I ON THE SEPARATE ANSWER SHEET ENCLOSED. No credit will be given for anything written in this examination booklet, but you may use the booklet for notes or scratchwork. After you have decided which of the suggested answers is best, COMPLETELY fill in the corresponding oval on the answer sheet. Give only one answer to each question. If you change an answer, be sure that the previous mark is erased completely.

Example:

Chicago is a

(A) state
(B) city
(C) country
(D) continent
(E) village

Sample Answer

Many candidates wonder whether or not to guess the answers to questions about which they are not certain. In this section of the examination, as a correction for haphazard guessing, one-fourth of the number of questions you answer incorrectly will be subtracted from the number of questions you answer correctly. It is improbable, therefore, that mere guessing will improve your score significantly; it may even lower your score, and it does take time. If, however, you are not sure of the correct answer but have some knowledge of the question and are able to eliminate one or more of the answer choices as wrong, your chance of getting the right answer is improved, and it may be to your advantage to answer such a question.

Use your time effectively, working as rapidly as you can without losing accuracy. Do not spend too much time on questions that are too difficult. Go on to other questions and come back to the difficult ones later if you have time. It is not expected that everyone will be able to answer all the multiple-choice questions.

2003

ENVIRONMENTAL SCIENCE

Section I

Time—1 hour and 30 minutes

Part A

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

Questions 1-4 refer to the following energy efficiencies, expressed as percentages.

(A) 100%
(B) 95%
(C) 30%
(D) 15%
(E) 1%

1. Approximate efficiency of an average coal-fired power plant
2. Approximate efficiency of the conversion of light energy to chemical energy in photosynthesis
3. Approximate percentage of electrical energy converted to heat in the average incandescent lightbulb
4. The maximum efficiency possible in an energy-conversion process that is not limited by the second law of thermodynamics

Questions 5-7 refer to the following processes.

(A) Photosynthesis
(B) Eutrophication
(C) Denitrification
(D) Decomposition
(E) Transpiration

5. The rapid rate of this process in tropical forests results in low-nutrient soils
6. The process in which glucose is synthesized by plants
7. The process by which a soil nutrient is reduced and released to the atmosphere as a gas

Questions 8-11 refer to the following elements.

(A) Oxygen
(B) Aluminum
(C) Iron
(D) Nitrogen
(E) Argon

8. The most abundant element in Earth's crust
9. The most abundant element in Earth's atmosphere
10. The most abundant element in Earth's core
11. The element commercially extracted from bauxite

Questions 12-14 refer to the following processes.

(A) Nitrification
(B) Denitrification
(C) Assimilation
(D) Ammonification
(E) Nitrogen fixation

12. Ammonia is converted to nitrite, then to nitrate.
13. Plant roots absorb ammonium ions and nitrate ions for use in making molecules such as DNA, amino acids, and proteins.
14. Nitrate ions and nitrite ions are converted into nitrous oxide gas and nitrogen gas (N_2).

GO ON TO THE NEXT PAGE

Questions 15-18 refer to the following air pollutants.

(A) Sulfur dioxide
(B) Lead
(C) Ozone
(D) Hydrocarbons
(E) Particulates

15. Most often cited as the causative factor for acid deposition

16. Implicated in human neurological damage

17. Considered harmful in the troposphere but beneficial in the stratosphere

18. Is the major pollutant that electrostatic precipitators are designed to remove from power-plant smokestack emissions

Questions 19-21 refer to the following countries.

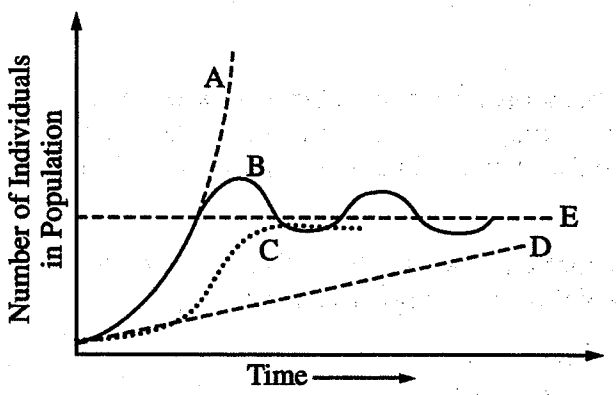
(A) Australia
(B) Brazil
(C) Chile
(D) Russia
(E) United States of America

19. Country with the largest area of boreal forests

20. Country with the greatest percentage of land area affected by desertification

21. Country with the largest area of temperate deciduous forest

Questions 22-24 refer to the figure below. A, B, C, and D represent population growth curves, E represents the carrying capacity.



22. Represents the maximum number of individuals that can be supported by a particular ecosystem on a long-term basis

23. Represents the biotic potential of the species

24. Represents the growth of a population predicted by the logistic model

GO ON TO THE NEXT PAGE

Part B

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

25. The most commonly used measure of the economic growth of a country is which of the following?

    (A) Gross national product
    (B) Level of exports
    (C) Level of imports
    (D) Fertility rate
    (E) Externalized costs

26. The factor that likely poses the greatest threat of extinction of species worldwide is

    (A) weakening of environmental legislation
    (B) increase in hunting and fishing
    (C) aggressive collecting of specimens by museums and zoos
    (D) black-market trade in endangered species
    (E) increasing loss of habitat

27. Which of the following energy sources is not derived directly or indirectly from solar energy?

    (A) Geothermal
    (B) Photovoltaic
    (C) Hydroelectric
    (D) Biomass
    (E) Wind

28. Which of the following best exemplifies global collaboration for a sustainable environment?

    (A) The Montreal Protocol
    (B) The Antarctic Treaty of 1961
    (C) The Clean Air Act of 1972
    (D) CERCLA (Superfund)
    (E) NAFTA

GO ON TO THE NEXT PAGE

29. Which of the following is an effective alternative to chlorine for disinfecting wastewater in a municipal treatment plant?

(A) Freon
(B) Alcohol
(C) Phosphate
(D) Ammonia
(E) Ozone

30. The presence of fecal coliform bacteria in a sample of river water suggests which of the following?

(A) The pH of the river is very high.
(B) The water is contaminated with animal waste.
(C) The river is devoid of plant life.
(D) The dissolved oxygen level of the river is high.
(E) Fish caught from the river will be free of parasites.

31. Which of the following best helps to explain why phosphorus is often a limiting factor in many ecosystems?

(A) There is usually a gaseous phase in the phosphorus cycle.
(B) Phosphorus cycles very quickly through environments.
(C) Under many conditions, phosphorus forms stable insoluble compounds.
(D) Phosphate is not readily taken up by plants.
(E) There are no anthropogenic sources of phosphorus.

32. Factors contributing to the rise in world hunger include all of the following EXCEPT

(A) unequal distribution of available food supplies
(B) loss of or decline in arable land
(C) increasing rate of population growth
(D) increasing poverty in developing countries
(E) increasing consumption of vegetable protein in place of meat protein

33. If a city of population 10,000 experiences 100 births, 40 deaths, 10 immigrants, and 30 emigrants in the course of a year, what is its net annual percentage growth rate?

(A) 0.4%
(B) 0.8%
(C) 1.0%
(D) 4.0%
(E) 8.0%

34. Which of the following statements about genetic diversity is true?

(A) Genetic uniformity of a crop increases the crop's overall resistance to pests and disease.
(B) Genetic resistance to pests and diseases can be increased by crossing a crop plant with ancestral varieties.
(C) Genetic engineering technology is used to increase genetic diversity by creating new species with synthetic genes.
(D) Genetic diversity within populations of common crop species such as corn is typically high.
(E) Genetic diversity is usually high in endangered species.

35. In the United States, most municipal solid waste is disposed of by

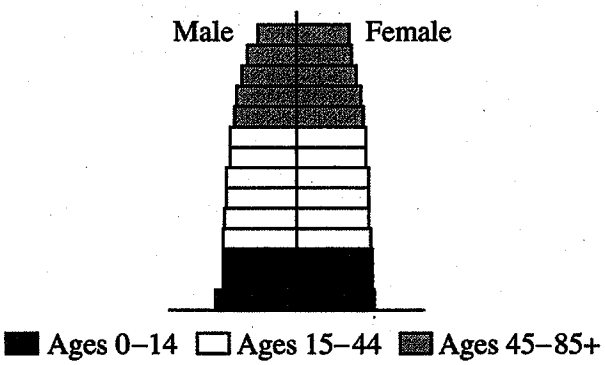
(A) composting
(B) recycling
(C) incineration
(D) ocean dumping
(E) landfilling

GO ON TO THE NEXT PAGE

36. Negative environmental impacts associated with large-scale hydroelectric projects have been demonstrated in which of the following areas?

(A) James Bay, Quebec
(B) Three Mile Island, Pennsylvania
(C) Kissimmee River, Florida
(D) Mono Lake, California
(E) Aral Sea, former USSR

AGE DISTRIBUTION



37. A country with an age distribution like that shown in the figure above, is most likely a country that

(A) is experiencing rapid growth
(B) is experiencing slow or no population growth
(C) is experiencing a high death rate
(D) has 40% of the population under age 15
(E) is a less-developed country

38. Which of the following factors is fundamentally responsible for seasons on Earth?

(A) The varying distance of Earth from the Sun
(B) The tilt of Earth's axis of rotation
(C) The latitudinal variation in temperature and precipitation
(D) The tidal pull of the Sun and Moon
(E) The anthropogenic greenhouse effect

39. If wastewater treatment plant effluent that contains nitrates and phosphates is allowed to flow into a body of water, which of the following may result?

(A) Chlorination
(B) Decomposition
(C) Eutrophication
(D) Oxygenation
(E) Methylation

40. Which of the following describes a fundamental characteristic of the green revolution in food resources?

(A) The application of higher levels of organic fertilizers to increase rice production
(B) Deforestation to provide field crops with increased sunlight for photosynthesis
(C) The addition of calorie, fat, and fiber percentages to the information provided on food package labels
(D) The development of new strains of crops with higher yields
(E) The discovery that chlorophyll adds nutritional value to wheat, rice, and sorghum

41. An industry uses natural gas for manufacturing and uses the waste heat to produce electricity. This is an example of which of the following processes?

(A) Cogeneration
(B) Electrolysis
(C) Gas hydration
(D) Gasification
(E) Reclamation

42. The water-holding capacity of soil is LEAST likely to be affected by the addition of which of the following?

(A) Clay
(B) Humus
(C) Manure
(D) Pesticide
(E) Sand

43. Critics of incineration of municipal solid waste suggest that it may <u>not</u> be the best solution for the future, for which of the following reasons?

(A) Incineration produces ash that increases landfill volume.
(B) Incineration generates methane.
(C) Incineration involves advanced technology.
(D) Incineration contributes to air pollution.
(E) Incineration requires large energy input.

GO ON TO THE NEXT PAGE

44. Which of the following is likely to minimize soil erosion?

(A) High-yield crops
(B) Deforestation
(C) Herbicide use
(D) Annual plowing
(E) No-till agriculture

45. A state highway was constructed over wetlands. The state obtained a permit to fill the existing wetlands in accordance with the provisions of the Clean Water Act of 1972, and agreed to create another wetland. This trade-off approach to addressing an environmental issue is known as

(A) mitigation
(B) restoration
(C) preservation
(D) remediation
(E) sustainability

46. Information gathered by a scientist about the toxicity of chemical *X* and chemical *Y* showed that they had individual safe limits for fish at particular concentrations. But when they were used together at the safe concentrations, there were extensive fish kills. This is an example of

(A) homeostasis
(B) synergism
(C) commensalism
(D) bioaccumulation
(E) antagonism

47. The polar regions radiate away more heat energy than they receive from the Sun in the course of a year. However, they are prevented from becoming progressively colder each year primarily by the

(A) absorption of ultraviolet radiation by snow
(B) transport of heat through the atmosphere and oceans
(C) concentration of Earth's magnetic field lines at the poles
(D) release of latent heat to the atmosphere when the polar ice caps melt
(E) generation of heat by glacial movement

48. An advantage of recycling aluminum rather than disposing of it in landfills is that aluminum can be

(A) produced from recycled metal using much less energy than is required for its production from aluminum ore
(B) produced from ore that is chemically reactive and dangerous to transport, store, and process
(C) produced from ore that is scarce and found primarily in remote, inhospitable regions at high latitudes
(D) absorbed by plants and then biomagnified in both terrestrial and aquatic food chains
(E) leached from landfills in the form of Al^{3+} ions that could increase the pH of lakes and streams

49. As urbanization increases and natural soil surfaces are covered, the groundwater supply is reduced due to

(A) increased evaporation and transpiration
(B) decreased surface runoff
(C) loss of recharge area
(D) confinement of aquifers
(E) capping of artesian wells

50. The current global human population is about 6.1 billion and is growing at an annual rate of 1.35 percent. If world population were to grow at this rate for the next year, approximately how many people would be added?

(A) 8×10^5
(B) 8×10^6
(C) 8×10^7
(D) 8×10^8
(E) 8×10^9

GO ON TO THE NEXT PAGE

51. Which of the following methods of agricultural irrigation results in the loss of the least amount of water by evaporation?

(A) Conventional center-pivot irrigation
(B) Drip irrigation
(C) Laser-level irrigation
(D) Flood irrigation
(E) Gravity-flow irrigation

52. Which of the following components of a wastewater treatment plant is designed to facilitate the decomposition of organic material by aerobic microorganisms?

(A) Bar screen
(B) Grit-settling tank
(C) Activated-sludge tank
(D) Chlorination tank
(E) Ultraviolet-light array

53. Ozone in the stratosphere is most important to life at Earth's surface because it absorbs

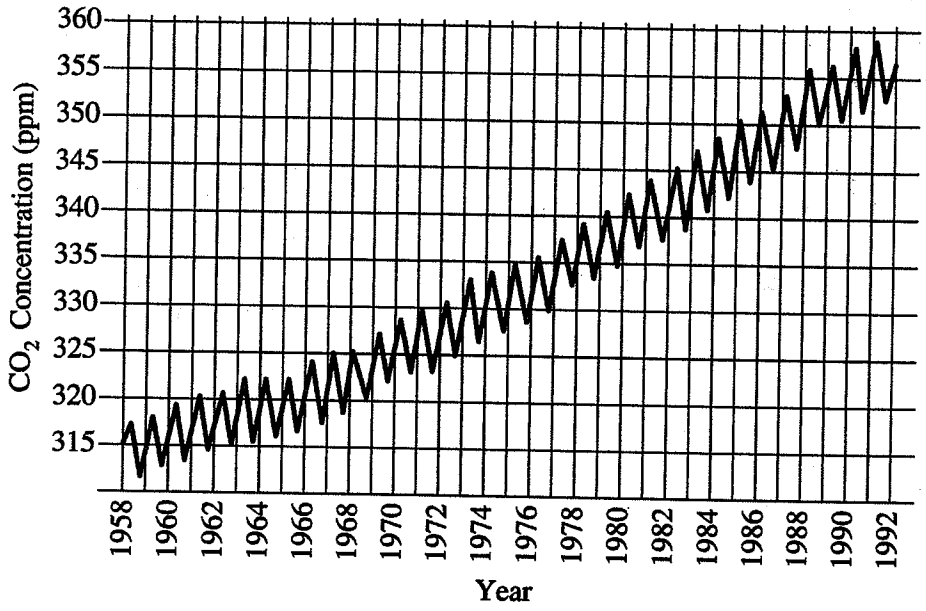
(A) gamma rays
(B) microwaves
(C) ultraviolet light
(D) visible light
(E) x-rays

54. The major source of radon in houses in the United States is

(A) furniture and carpets
(B) the underlying bedrock
(C) the troposphere
(D) nuclear power plants
(E) fossil-fuel combustion

GO ON TO THE NEXT PAGE

Questions 55-56 refer to the following graph.



55. The data in the graph can be useful in explaining the greenhouse effect when they are compared with

(A) volcanic activity
(B) sunspot activity
(C) mean global temperatures
(D) annual nitrous oxide production
(E) cycles of flooding and drought

56. The annual fluctuation in carbon dioxide concentration can best be explained by the

(A) seasonal use of fossil fuels
(B) regularity of volcanic activity
(C) deforestation in the tropics
(D) El Niño events
(E) seasonal photosynthetic activity of green plants

GO ON TO THE NEXT PAGE

57. Integrated waste management employs all of the following EXCEPT

(A) using refillable soft-drink bottles
(B) using disposable diapers instead of cloth diapers
(C) using reusable canvas bags instead of plastic or paper bags
(D) using tires for the construction of artificial reefs
(E) redesigning automobiles to replace steel parts with aluminum and plastic parts

Item 58 was not scored.

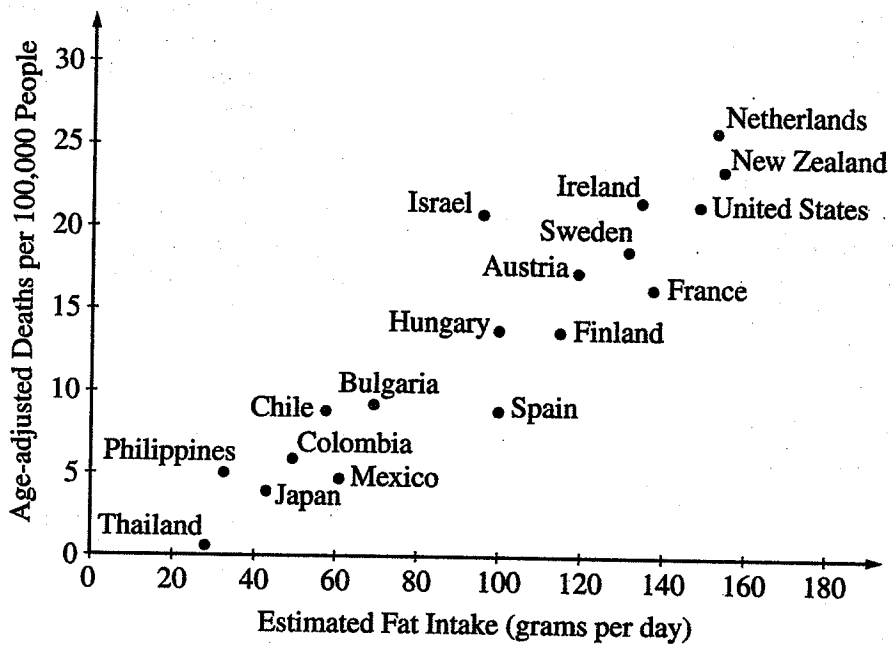
59. Economic benefits of building large dams include which of the following?

I. Storage of water for agriculture and domestic use
II. Controlling floods upstream
III. Production of renewable energy

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

GO ON TO THE NEXT PAGE

Questions 60-61 refer to the figure below, which depicts the observed relation between dietary fat intake and rate of death from breast cancer in different countries.



60. Which of the following statements is best supported by the data?

(A) Increased incidence of breast cancer is related to the average age of a country's population.
(B) The number of breast cancer deaths is proportional to the size of a country's population.
(C) Increased incidence of breast cancer is related to annual length of exposure to solar radiation.
(D) Persons who reside in colder climates are more susceptible to breast cancer than those who live in tropical regions.
(E) There is a positive correlation between breast cancer and dietary fat intake.

61. United States residents are how many times more likely to die from breast cancer than residents of Hungary?

(A) 150
(B) 21
(C) 14
(D) 7
(E) 1.5

GO ON TO THE NEXT PAGE

62. Of the following sources, which supplies the most commercial energy in the world today?

(A) Solar
(B) Oil
(C) Biomass
(D) Nuclear
(E) Hydroelectric

63. Which of the following is a greenhouse gas that is also a by-product of anaerobic respiration?

(A) Methane, CH_4
(B) Nitrogen, N_2
(C) Oxygen, O_2
(D) Nitrogen dioxide, NO_2
(E) Hydrogen sulfide, H_2S

64. If the population of a country grows at a rate of approximately 5 percent per year, the number of years required for the population to double is closest to

(A) 5 years
(B) 10 years
(C) 15 years
(D) 25 years
(E) 35 years

65. The major cause for the decline in the worldwide catch of fish since 1990 is

(A) acid deposition
(B) escalating price of fuel
(C) competition from aquaculture
(D) overfishing
(E) decline in market price

66. Which of the following will occur if the trend of global temperature increase continues?

(A) Night temperatures will decrease as day temperatures increase.
(B) Tropical areas will become cooler than they currently are.
(C) Sea levels will drop due to increased evaporation.
(D) The incidence of insect-borne diseases will decrease.
(E) The troposphere will contain more water vapor.

67. Which of the following is the primary environmental problem associated with the use of nuclear power to generate electricity?

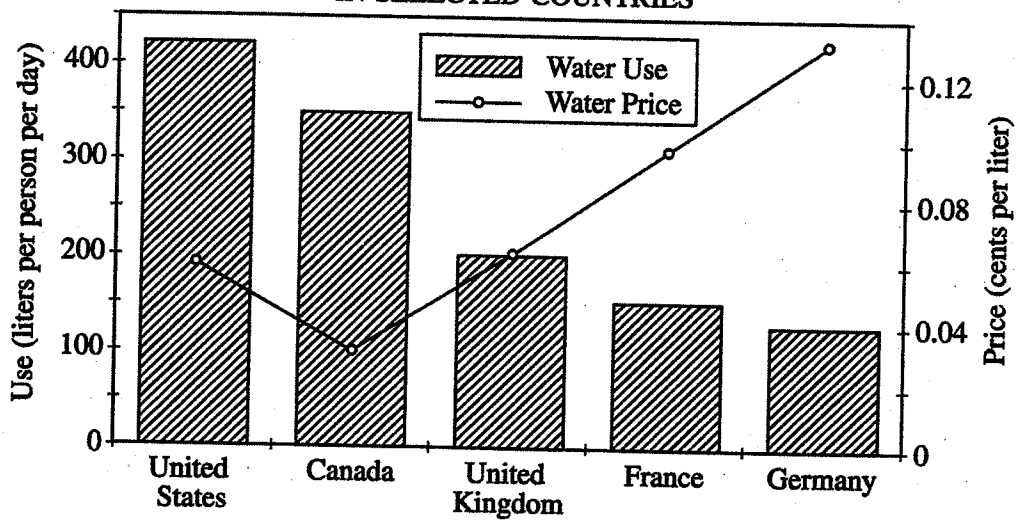
(A) Radon leaking into buildings
(B) Production of greenhouse gases such as carbon dioxide
(C) Disposal of radioactive waste
(D) Depletion of the ozone layer
(E) Production of acid rain

68. Compared to a coal-fired power plant that produces the same amount of energy, a nuclear power plant generates more

(A) CO_2
(B) SO_2
(C) fly ash
(D) particulates
(E) thermal pollution

GO ON TO THE NEXT PAGE

COMPARISON OF MUNICIPAL WATER PRICES AND USE IN SELECTED COUNTRIES



69. The chart above compares the daily water use per person to the price of water in selected countries. Which of the following conclusions can be correctly drawn using only the data in the chart?

(A) Water use and water price are directly proportional.
(B) Increased water use causes prices to decline.
(C) Increased prices cause water use to decline.
(D) Increased water use is generally correlated with lower water prices.
(E) Water is more plentiful in the United States and Canada than in the other countries.

GO ON TO THE NEXT PAGE

70. Which of the following identifies the two factors thought to be the most harmful to biodiversity?

(A) Acid deposition and increased use of fertilizers for agriculture
(B) Depletion of the ozone layer and oil drilling
(C) Destruction of habitat and invasion by nonnative species
(D) Changes in climate and proliferation of endemic species
(E) Global warming and decline in fisheries

71. For a certain insecticide, the LD-50 dosage level for rats is determined to be 250 milligrams per kilogram of body mass. On the basis of this information, which of the following is the best prediction regarding the consequences of receiving this dosage of the insecticide?

(A) Fifty percent of any rat population would be sickened.
(B) Fifty percent of the population of any warm-blooded animal would die.
(C) Fifty percent of any population of mosquitoes would die.
(D) Five hundred out of every one thousand people would experience acute effects.
(E) Five hundred out of every one thousand rats would die.

72. The major human health problem related to radon accumulation is

(A) lung cancer
(B) heart disease
(C) pancreatic cancer
(D) cataracts
(E) malignant melanoma

73. Why do introduced species often become pests?

(A) They displace native species.
(B) They increase biodiversity.
(C) They do not adapt well to local habitats.
(D) They contribute to habitat fragmentation.
(E) They have low biotic potential.

74. Acid rain is associated with which of the following?

(A) Formation of the antarctic ozone hole
(B) Release of PCBs into the atmosphere
(C) Damage to tropical rain forests
(D) The burning of fossil fuels
(E) The increasing pH of lake waters

75. Characteristics that tend to increase the risk of a species becoming endangered include which of the following?

I. Having a very limited distribution
II. Being a specialist at the end of a long food chain
III. Having a small population size

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

76. Stratospheric ozone depletion is most likely to result in which of the following?

(A) Increased growth of food crops due to increasing amounts of ultraviolet radiation
(B) Extended grazing season for cattle
(C) Disruption of photosynthesis in plants
(D) Increased movement of the human population toward equatorial regions
(E) A higher percentage of cloudless days

77. Which of the following is a process that indirectly removes carbon from Earth's atmosphere?

(A) Formation of carbonate deposits
(B) Outgassing by volcanoes
(C) Respiration by mammals
(D) Respiration by anaerobic bacteria
(E) Photodissociation by ultraviolet light

GO ON TO THE NEXT PAGE

78. Which of the following is the best explanation of the fact that agricultural production on floodplains is often relatively high?

(A) On floodplains, soils tend to be nutrient-rich and fertile.
(B) On floodplains, high water tables make irrigation unnecessary.
(C) Periodic flooding leaches toxic pollutants out of floodplain soils.
(D) Periodic flooding prevents the pH of floodplain soils from becoming too high.
(E) Floodplains are usually sparsely settled and thus more acreage is available for agriculture.

79. The increase in the size of Earth's human population in the last century has been dramatic. Which of the following identifies two major contributors to this increase?

(A) New methods of agriculture and the identification of new food crops
(B) The Industrial Revolution and modern medicine
(C) Increased emigration/immigration and decreased warfare
(D) New methods of birth control and decreased warfare
(E) Increased education for women and the development of new pesticides

80. Many scientists maintain that a rise in sea level has occurred in the last hundred years as a result of global warming. If this is true, which of the following factors best explains such a rise?

(A) Increased precipitation
(B) Increased cloud cover
(C) Increased evapotranspiration
(D) Thermal expansion of the ocean
(E) Melting of permafrost

81. Which of the following natural events would be most likely to contribute to the cooling of Earth's atmosphere?

(A) Earthquake
(B) Volcanism
(C) Hurricane
(D) Tsunami
(E) Monsoon

Item 82 was not scored.

83. At the current rate of growth, Earth's human population will double in about 50 years. Which of the following is the LEAST viable strategy for ensuring adequate nutrition for a population of this size?

(A) Increasing the number of new food crops from the great diversity of plant species
(B) Doubling the area of arable land on a global basis
(C) Developing systems for making the global distribution of food more equitable
(D) Increasing the area of land that is currently dedicated to grain production by reducing the area dedicated to meat production
(E) Assisting developing countries in using highly efficient crop irrigation systems

GO ON TO THE NEXT PAGE

84. The combustion of one gallon of automobile fuel produces about 5 pounds of carbon (in CO_2). Two autos are making a trip of 600 miles. The first auto gets 20 miles per gallon, and the second gets 30 miles per gallon. Approximately how much less carbon (in CO_2) will be produced by the second auto on this trip?

(A) 300 lbs
(B) 150 lbs
(C) 100 lbs
(D) 75 lbs
(E) 50 lbs

85. Which of the following best describes the significance of the United Nations Conference on the Human Environment, which was held in 1972 in Stockholm?

(A) Developing countries and developed countries were largely in agreement about the most important environmental problems.
(B) For the first time since the end of the Second World War, nations set aside their political differences to achieve a common objective.
(C) Environmental activists who had organized Earth Day in 1970 ran the conference.
(D) The conference provided the first global forum for dialogue on environmental problems.
(E) The delegates assembled at the conference voted in favor of controlling population growth.

86. Regulations that deal directly with the disposal of hazardous materials in the United States include which of the following?

I. RCRA
II. Clean Water Act
III. Clean Air Act

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

87. Which of the following is a true statement about replacement-level fertility?

(A) It equals the average number of children a woman will give birth to during her child-bearing years.
(B) It equals the annual number of live births per 1,000 people in a population.
(C) It equals the natural increase of a population in one year.
(D) It is found by subtracting the number of emigrants from the number of immigrants in one year.
(E) It is greater in countries with high infant-mortality rates than in countries with low infant-mortality rates.

88. Which of the following best illustrates the concept of the tragedy of the commons?

(A) Destruction of landscape by surface mining on private land
(B) Selective harvesting of trees by a timber company in a national forest
(C) Legislation of catch limits to avoid depletion of fish stocks in a shared lake
(D) Inadvertent destruction of beneficial species while attempting to control pests
(E) Depletion of an aquifer by regional farmers

GO ON TO THE NEXT PAGE

89. Of the following, which is the best example of reclamation of disturbed lands?

(A) Restoring vegetation to an area that has been mined
(B) Constructing a new wetland to compensate for the loss of wetlands
(C) Growing crops on land formerly used for grazing
(D) Reintroducing an endangered species into an area from which it has disappeared
(E) Regulating the use of a natural resource in order for it to renew itself

90. If the annual consumption of petroleum in the United States is about 23 barrels per capita, the total annual consumption of petroleum in the United States is closest to

(A) 12 million barrels
(B) 240 million barrels
(C) 2 billion barrels
(D) 6 billion barrels
(E) 10 billion barrels

91. One solution for reducing the amount of atmospheric carbon dioxide would be to

(A) increase oceanic temperatures to enhance carbon dioxide uptake
(B) increase the rate of removal of tropical rain forests
(C) decrease the total area of rice paddies
(D) decrease the use of fossil fuels
(E) decrease the production of chlorofluorocarbons

92. The drop in stratospheric ozone levels in the Southern Hemisphere (the "ozone hole") is most evident during which season?

(A) Antarctic spring (October)
(B) Antarctic autumn (April)
(C) Antarctic summer only (January)
(D) Antarctic winter only (July)
(E) Both Antarctic summer and Antarctic winter (January and July)

93. Uranium-235 has a half-life of 710 million years. If it is determined that a certain amount of stored U-235 will be considered safe only when its radioactivity has dropped to 0.10 percent of the original level, approximately how much time must the U-235 be stored securely to be safe?

(A) 7.1×10^6 years
(B) 7.1×10^7 years
(C) 7.1×10^8 years
(D) 7.1×10^9 years
(E) 7.1×10^{10} years

94. Which of the following would be the strongest evidence in support of a scientist's contention that a local area was experiencing acid deposition?

(A) A sudden die-off of all the fish in a local stream
(B) A gradual increase in the temperature of a local lake
(C) An increase in the rate of photosynthesis of aquatic plants in a local lake
(D) A long-term increase in the pH of a local pond
(E) An increase in the concentrations of soluble heavy metals in a local pond

GO ON TO THE NEXT PAGE

95. Which of the following is the usual cause of cultural eutrophication in surface waters of both developed and developing countries?

(A) Lack of proper filtration devices for power plant effluents
(B) Introduction of cyanobacteria to streams and rivers
(C) Runoff of metal ions in bodies of water
(D) Runoff of nitrate compounds into bodies of water
(E) Runoff of herbicides into bodies of water

96. If mean global temperature keeps on increasing as predicted by contemporary scientists, which of the following is most likely?

(A) There will be fewer insect pests and disease-carrying organisms.
(B) Specialist species living in fragile ecosystems will risk extinction.
(C) There will be an increase in sulfate concentrations in wetlands.
(D) There will be an increase in the reproductive rate of mammals.
(E) The geographical range of many plants will move toward the equator.

97. Photosynthesis is the major source of which of the following gases in Earth's atmosphere?

(A) CO_2
(B) H_2O (water vapor)
(C) O_2
(D) H_2
(E) N_2

Item 98 was not scored.

GO ON TO THE NEXT PAGE

99. Traveling southward from the Arctic regions of Canada to the tropics of Panama, one passes through several biomes—tundra, coniferous forest, temperate deciduous forest, and tropical rain forest. This pattern of change in vegetation is primarily the result of

(A) primary and secondary succession
(B) the invasion of exotic species
(C) an increase in mean annual temperature and a decrease in mean annual precipitation
(D) an increase in both mean annual temperature and mean annual precipitation
(E) an increase in the total annual hours of sunlight

100. Which statement best describes the approximate global distribution of coal supplies?

(A) Brazil and South Africa together contain 33% of proven reserves.
(B) The United States contains 40% of proven reserves.
(C) Australia, Japan, and France together contain 45% of proven reserves.
(D) The United States, the former Soviet Union, and China together contain 50% of proven reserves.
(E) Germany, Brazil, and India together contain 75% of proven reserves.

END OF SECTION I

ENVIRONMENTAL SCIENCE
SECTION II
Time—90 minutes
Number of questions—4
Percent of total grade—40

Suggested writing time per question—approximately 22 minutes

Because each question will be weighted equally, you are advised to divide your time equally among them without spending too much time on any one question. You are expected to answer all four questions in this section. The parts within a question may not have equal weights. Suggested times will not be announced; you may proceed freely from one question to the next.

Each answer should be organized, well balanced, and as comprehensive as time permits. Answers must be in organized, well-written prose form; outline form is NOT acceptable. Do not spend time restating the questions. If a specific number of examples are called for, no credit will be given for additional examples. For instance, if a question calls for two examples, you will receive credit only for the first two examples you provide.

The questions in the green insert are duplicates of those in this booklet. Use the green insert to organize your answers and for scratchwork, but write your answers in the pink booklet. NO CREDIT WILL BE GIVEN FOR ANYTHING WRITTEN IN THE GREEN INSERT.

You are to write your answers with a pen only, preferably in black or dark blue ink. Be sure to write CLEARLY and LEGIBLY. If you make an error, you may save time by crossing it out rather than trying to erase it.

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

Section II

ENVIRONMENTAL SCIENCE
SECTION II
Time—90 minutes
4 Questions

Directions: Answer all four questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers on the pages following the questions in the pink booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples.

1. Read the following article from the *Fremont Examiner*.

FREMONT EXAMINER

Worm Invasion

A researcher studying the ecology of the deciduous forest outside of Fremont has made an alarming discovery. While taking an inventory of the species present on the forest floor, Professor Peter Tate discovered many earthworms of an Asian species not previously known to live in this area. The Asian worms, unlike native worms, have voracious appetites.

The forest floor is home to a myriad of species that live in the leaf litter, which is composed of several years' accumulation of slowly decomposing leaves. Dr. Tate explained that "the leaf litter is critical to the survival of local species of forest plants." Dr. Tate has found the Asian worms, unlike their indigenous cousins, consume the entire layer of leaf litter in a single season. He said, "This sets the stage for the takeover by invasive exotics such as Japanese stilt grass." Dr. Tate and other scientists are exploring strategies for the control of the Asian worms.

(a) Support Dr. Tate's assertion that "the leaf litter is critical to the survival of local species of forest plants." Include in your discussion the roles of leaf litter in a deciduous forest ecosystem.

(b) Describe THREE abiotic changes that would be likely to result if the exotic worms consumed all the leaf litter in a single year.

(c) For one of the changes you identified in part (b), explain how the change could set the stage for the takeover of Japanese stilt grass or other exotic species.

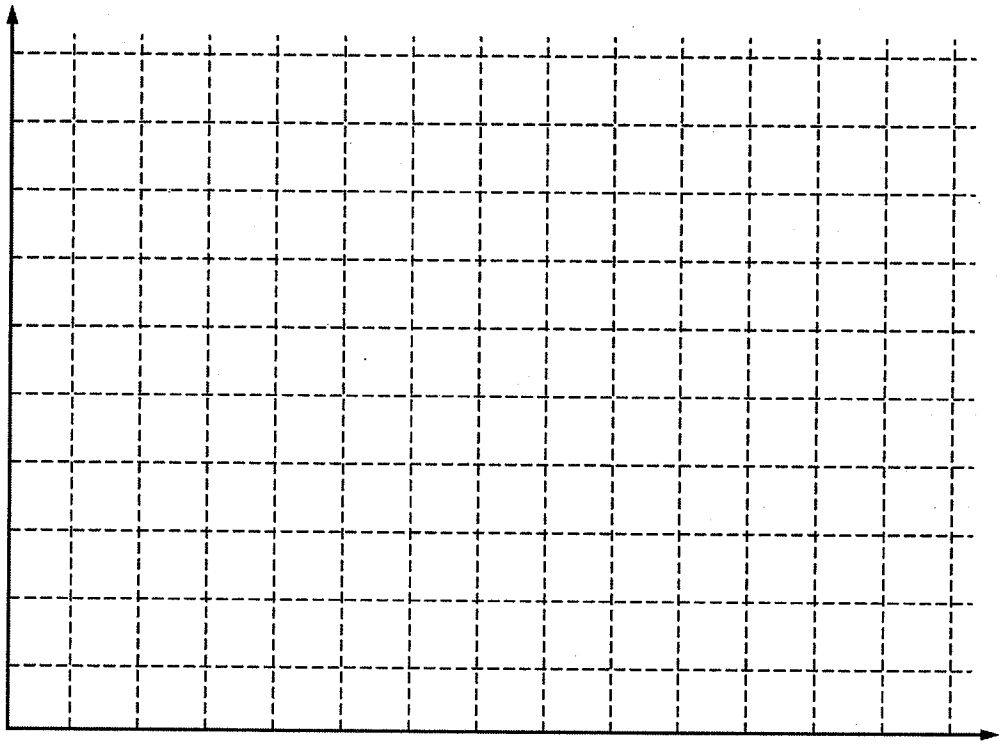
(d) Design a controlled experiment to determine whether the worms, in fact, do change the forest ecosystem. Identify the environmental factor you will measure, and include the specific hypothesis you will test and the data you will collect.

GO ON TO THE NEXT PAGE

2. A certain fictional country called Industria is tracking its population data. In 1855, the first year vital statistics were reported for the country, the population was 1.6 million, with a crude birth rate of 43 per 1,000. At that time the population of Industria was growing quite slowly, because of the high death rate of 41 per 1,000. In 1875 the population began to grow very rapidly as the birth rate remained at its 1855 level, while the crude death rate dropped dramatically to 20 per 1,000. Population growth continued to increase in the small country into the late 1800's, even though birth rates began to decline slowly.

   In 1895 the crude birth rate had dropped to 37, and the death rate to 12 per 1,000. In that year (1895) a complete census revealed that the population of Industria had grown to 2.5 million. By 1950 population growth gradually began to decline as the death rate remained at its 1895 level, while the birth rate continued to decline to 22 per 1,000. In 1977 vital statistics revealed that the death rate was 10 per 1,000, and that population growth had slowed even more to an annual rate of 0.4%. By 1990 Industria had reduced its birth rate to that of its now constant, low death rate, and the population transition was complete.

   (a) On the axes below, plot the crude birth-rate data from 1855 to 1990. Now plot the crude death-rate data on the same axes. Clearly label the axes and the curves.



   (b) What was the annual growth rate of Industria in 1950? What was the birth rate in Industria in 1977?

   (c) Indicate TWO factors that might have accounted for the rapid decline in the death rate in Industria between 1855 and 1895. Indicate one specific reason why the birth rate might have been so high in 1855 and was so slow to decrease between 1855 and 1950.

   (d) Determine what the population size of Industria would have been in 1951 if the population had continued to grow at the annual rate of growth recorded for Industria in 1895.

GO ON TO THE NEXT PAGE

Section II

3. Environmental conditions in coastal estuaries vary hourly and seasonally.

   (a) Discuss TWO important causes for the variation in the temperature and/or salinity of an estuary. Be sure to include the connection between each cause and temperature and/or salinity.

   (b) Discuss TWO roles that coastal wetlands play that are ecologically important, and TWO roles that wetlands play that are economically important.

   (c) Identify and explain THREE ways in which humans have had a negative impact on or have degraded coastal wetlands.

   (d) Choose one of the negative human impacts you identified in part (c), and explain one environmental policy and one economic incentive that could have prevented it.

4. The American whooping crane and the California condor are two of North America's largest birds. Although both are rare and endangered, they are protected, and large preserves are available for them. The two species, however, seem to be responding differently to these conservation efforts.

   In 1937, the whooping crane population was reduced to 14 individuals. It has since recovered; currently more than 200 birds live and breed in the wild. In the preservation of endangered species, the whooping crane is a success story. On the other hand, the California condor population declined rapidly so that no birds remained in the wild between 1987 and 1992. Condors were reintroduced into the wild after 1992 and approximately 50 condors currently live in the wild in California and Arizona. However, the recovery program cannot yet be considered a success.

   (a) Identify and describe TWO major causes for the original decline of these species. (You may describe one cause for each species or two causes for one species.)

   (b) Describe TWO measures that have been taken to protect these species. (Specify which of the species benefited from each measure.)

   (c) Describe TWO important characteristics of an endangered species that would cause it to be slow to recover.

   (d) Make one economic or ecological argument for protecting the condor, the whooping crane, or another endangered species that you identify and make one economic or ecological argument against protecting it.

END OF EXAMINATION