The College Board

AP® ADVANCED PLACEMENT PROGRAM®

Course Description

# ENVIRONMENTAL SCIENCE

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The College Board is a national nonprofit membership association dedicated to preparing, inspiring, and connecting students to college and opportunity. Founded in 1900, the association is composed of more than 3,900 schools, colleges, universities, and other educational organizations. Each year, the College Board serves over three million students and their parents, 22,000 high schools, and 3,500 colleges, through major programs and services in college admission, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT®, the PSAT/NMSQT™, the Advanced Placement Program® (AP®), and Pacesetter®. The College Board is committed to the principles of equity and excellence, and that commitment is embodied in all of its programs, services, activities, and concerns.



Visit College Board on the Web: **www.collegeboard.com/ap.**

Dear Colleagues:

Last year more than three quarters of a million high school students benefited from the opportunity of studying in AP courses and then taking the challenging AP Exams. These students experienced the power of learning as it comes alive in the classroom, as well as the practical benefits of earning college credit and placement while still in high school. Behind each of these students was a talented, hardworking teacher. Teachers are the secret to the success of AP. They are the heart and soul of the Program.

The College Board is committed to supporting the work of AP teachers in as many ways as possible. AP workshops and Summer Institutes held around the globe provide stimulating professional development for 60,000 teachers each year. The College Board Fellows stipends provide funds to support many teachers' attendance at these institutes, and in 2001, stipends were offered for the first time to teams of Pre-AP™ teachers as well.

Perhaps most exciting, the College Board continues to expand an interactive Web site designed specifically to support AP teachers. At this Internet site, teachers have access to a growing array of classroom resources, from textbook reviews to lesson plans, from opinion polls to cutting-edge exam information. I invite all AP teachers, particularly those who are new to the Program, to take advantage of these resources.

This AP Course Description provides an outline of content and description of course goals, while still allowing teachers the flexibility to develop their own lesson plans and syllabi, and to bring their individual creativity to the AP classroom. Additional resources, including sample syllabi, can be found in the AP Teacher's Guide that is available for each AP subject.

As we look to the future, the College Board's goal is to provide access to AP courses in every high school. Reaching this goal will require a lot of hard work. We encourage you to help us build bridges to college and opportunity by finding ways to prepare students in your school to benefit from participation in AP.

Sincerely,

Gaston Caperton
President
The College Board

# Contents

# Welcome to the AP Program

The Advanced Placement Program is sponsored by the College Board, a non-profit membership association. AP offers 35 college-level courses and exams in 19 subject areas for highly motivated students in secondary schools. Its reputation for excellence results from the close cooperation among secondary schools, colleges, and the College Board. More than 2,900 universities and colleges worldwide grant credit, advanced placement, or both to students who have performed satisfactorily on the exams, and 1,400 institutions grant sophomore standing to students who meet their requirements. Approximately 13,000 high schools throughout the world participate in the AP Program; in May 2000, they administered more than 1.3 million AP Exams.

You will find more information about the AP Program at the back of this Course Description, and at www.collegeboard.com/ap. This Web site is maintained for the AP Program by collegeboard.com, a destination Web site for students and parents.

## AP Courses

AP courses are available in the subject areas listed on the next page. (Unless noted, an AP course is equivalent to a full-year college course.) Each course is developed by a committee composed of college faculty and AP teachers. Members of these Development Committees are appointed by the College Board and serve for overlapping terms of up to four years.

## AP Exams

For each AP course, an AP Exam is administered at participating schools and multischool centers worldwide. Schools register to participate by completing the AP Participation Form and agreeing to its conditions. For more details, see *A Guide to the Advanced Placement Program*; information about ordering and downloading this publication can be found at the back of this booklet.

Except for Studio Art — which consists of a portfolio assessment — all exams contain a free-response section (either essay or problem-solving) and another section consisting of multiple-choice questions. The modern language exams also contain a speaking component, and the Music Theory exam includes a sight-singing task.

| AP Subject Areas | AP Courses and Exams |
|---|---|
| Art | Art History; Studio Art: Drawing Portfolio; Studio Art: 2-D Portfolio; Studio Art: 3-D Portfolio |
| Biology | Biology |
| Calculus | AB; BC |
| Chemistry | Chemistry |
| Computer Science | A*; AB |
| Economics | Macroeconomics*; Microeconomics* |
| English | Language and Composition; Literature and Composition; International English Language (APIEL™) |
| Environmental Science | Environmental Science* |
| French | Language; Literature |
| German | Language |
| Geography | Human Geography* |
| Government and Politics | Comparative*; United States* |
| History | European; United States; World |
| Latin | Literature; Vergil |
| Music | Music Theory |
| Physics | B; C: Electricity and Magnetism*; C: Mechanics* |
| Psychology | Psychology* |
| Spanish | Language; Literature |
| Statistics | Statistics* |

* This subject is the equivalent of a half-year college course.

## Equity and Access

The College Board and the Advanced Placement Program encourage teachers, AP Coordinators, and school administrators to make equity and access guiding principles for their AP programs. The College Board is committed to the principle that all students deserve an opportunity to participate in rigorous and academically challenging courses and programs. The Board encourages the elimination of barriers that restrict access to AP courses for students from ethnic and racial groups that have been traditionally underrepresented in the AP Program.

For more information about equity and access in principle and practice, contact the National Office in New York.

# Introduction to AP Environmental Science

Shaded text indicates important new changes in this subject.

The AP Environmental Science course is designed to be the equivalent of a one-semester, introductory college course in environmental science. Unlike most other college introductory-level science courses, environmental science is offered from a wide variety of departments, including geology, biology, environmental studies, environmental science, chemistry, and geography. Depending on the department offering the course, different emphases are placed on various topics. Some courses are rigorous science courses that stress scientific principles and analysis, and that often include a laboratory component; other courses emphasize the study of environmental issues from a sociological or political perspective rather than a scientific one. The AP Environmental Science course has been developed to be most like the former; as such, it is intended to enable students to undertake, as first-year college students, a more advanced study of topics in environmental science, or alternatively, to fulfill a basic requirement for a laboratory science and thus free time for taking other courses.

The AP Course Description and AP Examination have been prepared by environmental scientists and educators who serve as members of the AP Environmental Science Development Committee. In both breadth and level of detail, the content of the course reflects what is found in many introductory college courses in environmental science. The examination is representative of such a course and therefore is considered appropriate for the measurement of skills and knowledge in the field of environmental science.

## The Course

The goal of the AP Environmental Science course is to provide students with the scientific principles, concepts, and methodologies required to understand the interrelationships of the natural world, to identify and analyze environmental problems both natural and human-made, to evaluate the relative risks associated with these problems, and to examine alternative solutions for resolving and/or preventing them.

Environmental science is interdisciplinary; it embraces a wide variety of topics from different areas of study. Yet there are several major unifying constructs, or themes, that cut across the many topics included in the

study of environmental science. The following themes provide a foundation for the structure of the AP Environmental Science course.

1. Science is a process.
   - Science is a method of learning more about the world.
   - Science constantly changes the way we understand the world.
2. Energy conversions underlie all ecological processes.
   - Energy cannot be created; it must come from somewhere.
   - As energy flows through systems, at each step more of it becomes unusable.
3. The Earth itself is one interconnected system.
   - Natural systems change over time and space.
   - Biogeochemical systems vary in ability to recover from disturbances.
4. Humans alter natural systems.
   - Humans have had an impact on the environment for millions of years.
   - Technology and population growth have enabled humans to increase both the rate and scale of their impact on the environment.
5. Environmental problems have a cultural and social context.
   - Understanding the role of cultural, social, and economic factors is vital to the development of solutions.
6. Human survival depends on developing practices that will achieve sustainable systems.

## Student Selection

The AP Environmental Science course is an excellent option for any interested student who has completed two years of high school laboratory science—one year of life science and one year of physical science (for example, a year of biology and a year of chemistry). Due to the quantitative analysis that is required in the course, students should also have taken at least one year of algebra. Also desirable (but not necessary) is a course in earth science. Because of the prerequisites, AP Environmental Science will usually be taken in either the junior or senior year.

Admission to an AP course ordinarily depends on the student's interest in the subject as well as on a superior academic record. Experience has shown that the most successful students in AP courses are those who are both well prepared and highly motivated. AP Environmental Science, a rigorous science course with several prerequisites, is no exception. Yet, because many high school students express interest

in the environment and environmental issues, it is expected that this interest may provide an incentive for students (some of whom might otherwise not opt for an AP course in science) to enroll in AP Environmental Science.

### Textbooks

The following textbooks are commonly used in colleges, and are examples of texts that are appropriate for an AP Environmental Science course. Inclusion of a text in the list below does not constitute endorsement by the College Board, ETS, or the AP Environmental Science Development Committee.

Botkin, Daniel B., and Edward A. Keller. *Environmental Science: Earth as a Living Planet*, 3rd ed., New York: John Wiley & Sons, 2000, www.wiley.co.uk

Cunningham, William P., and Barbara Woodworth Saigo. *Environmental Science: A Global Concern*, McGraw Hill, 2000, www.mhhe.com

Enger, Eldon D., and Bradley F. Smith. *Environmental Science: A Study of Interrelationships*, 7th ed., McGraw Hill, 1998, www.mhhe.com

Miller, G. Tyler, Jr. *Living in the Environment: Principals, Connections, and Solutions*, 11th ed., Belmont, CA: Wadsworth, 2000, www.wadsworth.com

Raven, Peter H., Linda R. Berg, and George B. Johnson. *Environment*, 3rd ed., Ft. Worth, TX: Harcourt College Publishers, 2001, www.harcourtcollege.com

Supplemental resources for teachers include the following:

Allen, John L., ed. *Environment 98/99*, Annual Editions, 20th ed., McGraw Hill, 2001, www.mhhe.com

Goldfarb, Theodore D., ed. *Taking Sides: Clashing Views on Controversial Environmental Issues*, 9th ed., McGraw Hill, 2001.

For more information and to find out how to subscribe to an online discussion group with other AP teachers, please see the AP section of the College Board Web site: www.collegeboard.com/ap

## Topic Outline

Following is an outline of major topics, which serves to define the scope of both the AP Environmental Science course and the AP Exam. The order of topics in the outline holds no special significance, since there

are many different sequences in which the topics can be appropriately addressed in the course. It is expected that teachers will cover major environmental topics such as acid rain, loss of biodiversity and global warming. These may fit in more than one area of the content outline below, for example, acid rain (I.B.1.; I.D.2.; IV.A.2.c.). The percentage after each major topic heading shows the approximate proportion of questions on the examination that pertain to that heading; thus the percentage also indicates the relative emphasis that should be placed on the topics in the course.

I. Interdependence of Earth's Systems: Fundamental Principles and Concepts (25%)
   A. The Flow of Energy
      1. forms and quality of energy
      2. energy units and measurements
      3. sources and sinks, conversions
   B. The Cycling of Matter
      1. water
      2. carbon
      3. major nutrients
         a. nitrogen
         b. phosphorus
      4. differences between cycling of major and trace elements
   C. The Solid Earth
      1. Earth history and the geologic time scale
      2. Earth dynamics: plate tectonics, volcanism, the rock cycle, soil formation
   D. The Atmosphere
      1. atmospheric history: origin, evolution, composition, and structure
      2. atmospheric dynamics: weather, climate
   E. The Biosphere
      1. organisms: adaptations to their environments
      2. populations and communities: exponential growth, carrying capacity
      3. ecosystems and change: biomass, energy transfer, succession
      4. evolution of life: natural selection, extinction

II. Human Population Dynamics (10%)

A. History and Global Distribution
   1. numbers
   2. demographics, such as birth and death rates
   3. patterns of resource utilization

B. Carrying Capacity—Local, Regional, Global

C. Cultural and Economic Influences

III. Renewable and Nonrenewable Resources: Distribution, Ownership, Use, Degradation (15%)

A. Water
   1. fresh: agricultural, industrial, domestic
   2. oceans: fisheries, industrial

B. Minerals

C. Soils
   1. soil types
   2. erosion and conservation

D. Biological
   1. natural areas
   2. genetic diversity
   3. food and other agricultural products

E. Energy
   1. conventional sources
   2. alternative sources

F. Land
   1. residential and commercial
   2. agricultural and forestry
   3. recreational and wilderness

IV. Environmental Quality (20-25%)

A. Air/Water/Soil
   1. major pollutants
      a. types, such as $SO_2$, $NO_x$, and pesticides
      b. thermal pollution
      c. measurement and units of measure such as ppm, pH, µg/L
      d. point and nonpoint sources (domestic, industrial, agricultural)

2. effects of pollutants on:
    a. aquatic systems
    b. vegetation
    c. natural features, buildings and structures
    d. wildlife
3. pollution reduction, remediation, and control

B. Solid Waste
1. types, sources, and amounts
2. current disposal methods and their limitations
3. alternative practices in solid waste management

C. Impact on Human Health
1. agents: chemical and biological
2. effects: acute and chronic, dose-response relationships
3. relative risks: evaluation and response

V. Global Changes and Their Consequences (15-20%)

A. First-order Effects (changes)
1. atmosphere: $CO_2$, $CH_4$, stratospheric $O_3$
2. oceans: surface temperatures, currents
3. biota: habitat destruction, introduced exotics, overharvesting

B. Higher-order Interactions (consequences)
1. atmosphere: global warming, increasing ultraviolet radiation
2. oceans: increasing sea level, long-term climate change, impact on El Niño
3. biota: loss of biodiversity

VI. Environment and Society: Trade-Offs and Decision Making (10%)

A. Economic Forces
1. cost-benefit analysis
2. marginal costs
3. ownership and externalized costs

B. Cultural and Aesthetic Considerations

C. Environmental Ethics

D. Environmental Laws and Regulations (International, National, and Regional)

E. Issues and options (conservation, preservation, restoration, remediation, sustainability, mitigation)

## Laboratory and Field Investigation

Because it is designed to be a course in environmental *science* rather than in environmental studies, the AP Environmental Science course must include a strong laboratory and field investigation component. The goal of this component is to complement the classroom portion of the course by allowing students to learn about the environment through firsthand observation. Experiences both in the laboratory and in the field provide students with important opportunities to: test concepts and principles that are introduced in the classroom, explore specific problems with a depth not easily achieved otherwise, and gain an awareness of the importance of confounding variables that exist in the "real world." In these experiences students can employ alternative learning styles to reinforce fundamental concepts and principles. Because all students have a stake in the future of their environment, such activities can motivate students to study environmental science in greater depth.

Laboratory and field investigation activities in the course should be diverse. As examples, students can acquire skills in specific techniques and procedures (such as collecting and analyzing water samples), conduct a long-term study of some local system or environmental problem (such as the pollution of a nearby stream), analyze a real data set (such as mean global temperatures over the past 100 years), and visit a local public facility (such as a water-treatment plant).

Although there is a great diversity in the laboratory and field activities that would be appropriate for the course, they should include the following elements.

1. The activity should always be linked to a major concept in science and to one or more areas of the course outline.
2. The activity should allow students to have direct experience with an organism or system in the environment.
3. The activity should involve observation of phenomena or systems, the collection and analysis of data and/or other information, and the communication of observations and/or results.

The relative magnitudes of these elements may vary from activity to activity. As a whole, the course's laboratory and field investigation component should encompass all of the elements.

The laboratory and field investigation component of the AP Environmental Science course should challenge the students' abilities to:

— critically observe environmental systems
— develop and conduct well-designed experiments
— utilize appropriate techniques and instrumentation

— analyze and interpret data, including appropriate statistical and graphical presentations
— think analytically and apply concepts to the solution of environmental problems
— make conclusions and evaluate their quality and validity
— propose further questions for study
— communicate accurately and meaningfully about observations and conclusions

## Sample Laboratory and Field Investigations

Eighteen sample laboratory/field investigations are described below. It should be noted that these activities are provided here as examples only; they are NOT meant to represent a required or complete laboratory/field investigation program. Each sample activity is cross-referenced to the major topic in the topic outline (I–VI) to which it is relevant and to possible resources (by author) for the activity. A brief list of the materials and equipment required for each sample activity is also included.

Due to the broad scope and interdisciplinary nature of environmental science, the laboratory and field investigation activities should be drawn from many areas of scientific study, such as biology, ecology, chemistry, physics, geology, meteorology, and oceanography. The laboratory/field component of the AP Environmental Science course should include a diversity of experiences (e.g., experimental design, structural observation, field trips, and analysis of existing sets of data). It is not likely that a single laboratory manual can serve to effectively address the diverse elements of the course.

**1. Introductory Environmental Journal**

**Relevant Topic:** I.E.

**Objectives:**
- To observe an organism in the schoolyard environment
- To measure abiotic environmental factors, such as air and soil temperature, humidity, precipitation, wind speed and direction, cloud cover, barometric pressure
- To describe the biotic environment of an organism
- To collect qualitative and quantitative data
- To propose hypotheses that suggest ways in which people affect an organism and its environment

**Resources:** Tomera, Wolf

**Materials/Equipment:** Metric ruler, hand lens, Celsius thermometer, wind speed and direction indicator, barometer, hygrometer (optional: digital weather station)

**2. The Dynamics of Plate Tectonics: Earthquakes and Volcanic Activity**

**Relevant Topic:** I.C.

**Objectives:**
- To describe the theory of Plate Tectonics and its relationship to earthquake and volcanic activity
- To interpret seismograms (S & P waves) as used to locate earthquake epicenters
- To identify the general effects of volcanic eruptions and the relationship to weather patterns
- To relate plate tectonics to changing rates of evolution and the diversity of organisms

**Resources:** Anderson; Moyle, Rosenzweig; The World Resources Institute

**Materials/Equipment:** VCR, lab booklets, colored pencils, drafting compass, metric ruler, 386 IBM computer or compatible computer, CD-ROM drive, Microsoft Windows 3.1 or higher

**3. The Rock Cycle and Soil Formation**

**Relevant Topic:** I.C.

**Objectives:**
- To describe the effects of mechanical and chemical weathering on several rock samples
- To measure the rate of weathering in several rock samples
- To relate the physical and chemical processes involved in weathering to soil formation
- To identify examples of weathering in the student's environment

**Resources:** Enger; Ward's *Exploring Mechanical and Chemical Weathering*

**Materials/Equipment:** Rock samples (sandstone, conglomerate, granite, marble, limestone, dolomite), plastic jars, glass jars (8 and 16 ounce), strainer, magnifier, shallow aluminum dishes, glass vial, graduated cylinder (100 ml), laboratory balance, dilute HCl or vinegar, nail, heat source, tongs, empty coffee can

**4. Environmental Influences on Population Distribution**

**Relevant Topic:** I.E.

**Objectives:**
- To isolate several abiotic environmental variables
- To measure the effect of environmental variables on the distribution of a population
- To compare test results to a control
- To identify environmental variables that are significant
- To describe the habitat preferences of a laboratory organism

**Resources:** Enger

**Materials/Equipment:** Test containers (i.e., plastic troughs), 1% HCl, 1% KOH, crushed ice, infrared heat lamp, light source, cardboard, laboratory organisms (i.e., brine shrimp)

**5. Population Studies—in the Laboratory**

**Relevant Topic:** I.E.

**Objectives:**
- To graph and interpret data obtained from the growth of a population
- To calculate doubling time
- To observe the effects of rapid, unchecked population growth
- To define carrying capacity in terms of limiting factors
- To interpret population growth models

**Resources:** Alexander, Lopez, Tomera

**Materials/Equipment:** Fruit flies (*Drosophila*), ether, cotton balls, dissecting microscope, white paper, paint brushes, jars and medium for growing *Drosophila*, IBM computer (or IBM-compatible computer)

**6. Population Studies—in the Field**

**Relevant Topic:** I.E.

**Objectives:**
- To determine the organisms in a field community using the quadrant or transect sampling method
- To calculate population density
- To identify stages of succession within the study area
- To construct a food web for the field community

**Resources:** Alexander, Enger, Harley, Tomera

**Materials/Equipment:** String, wood stakes, meter stick, field guides to flora and fauna, plastic bags for specimens, insect nets

**7. Human Population Demographics**

**Relevant Topic:** II

**Objectives:**
- To determine the population growth rate of different human populations by calculating percent growth rate and doubling time
- To construct and interpret population age structure histograms for several countries
- To describe human populations in terms of age distribution, birth rates, death rates, and male/female ratios
- To analyze the impact of population growth rate on the utilization of global resources

**Resources:** Alexander, Enger, Harley (simulation), The World Resources Institute

**Materials/Equipment:** Calculator, data sheets, IBM computer (or IBM-compatible computer)

**8. Soil Analysis**

**Relevant Topic:** III

**Objectives:**
- To measure the slope of an area
- To identify the horizons in a soil profile
- To describe soil characteristics such as color, texture, and water-holding capacity
- To identify the chemical composition of soil (pH, nitrogen, phosphorus, and potash)
- To identify suitable land use options

**Resources:** Alexander, Ward's *Exploring Porosity and Permeability* (water-holding only)

**Materials/Equipment:** Meter sticks, centimeter rulers, leveling instruments, soil probes, soil-test kits, sample containers

**9. Energy Consumption**

**Relevant Topics:** III, VI

**Objectives:**
- To analyze energy-consumption data, such as for natural gas, electricity, and gasoline
- To calculate monthly and/or annual costs
- To identify renewable and nonrenewable energy resources
- To propose a plan of action to conserve and preserve energy resources

**Resources:** Enger, Roa, Rockett, Wolf, The World Resources Institute

**Materials/Equipment:** Suitable data sets, calculator, graph paper, IBM computer (or IBM-compatible computer)

**10. Air Pollution**

**Relevant Topic:** IV

**Objectives:**
- To collect and measure airborne particulate matter
- To compare data collected to the EPA National Ambient Air Quality Standards
- To relate weather and topography to air pollution
- To identify major types of air pollution and their sources
- To determine the effects of airborne particulate matter on human health

**Resources:** Alexander, Harley, The World Resources Institute

**Materials/Equipment:** Forceps, glass microfiber filters (8" x 10") or Millipore field-monitor filters, envelopes, desiccator, HI-volume air sampler, prepared slides of smoker's lung, miner's lung and healthy lung tissue, microscope with an ocular micrometer, IBM computer or IBM-compatible computer

**11. Toxicity Testing**

**Relevant Topic:** IV

**Objectives:**
- To measure the effect of various toxic materials on a laboratory population
- To determine the LD50 for various toxic materials
- To relate toxicity test results to environmental degradation and human health

**Resources:** Enger, Harley, Mitchell (*Heavy Metals Manual*)

**Materials/Equipment:** $CuSO_4$ solutions (10%, 1%, 0.1%, 0.01%), petri dishes, eyedroppers, filter paper, various chemical "pollutants" (such as

combined sewer overflow, vinegar, aspirin, rubbing alcohol, coffee, motor oil, pesticide, zinc chloride, mice or rat droppings, stream water—the chemicals used depend on the specific laboratory activity), laboratory organisms (such as brine shrimp, yeast, protists, Daphnia, lettuce seeds). Note: the composition of the stream water may be analyzed by the use of a spectrophotometer.

### 12. Water-Quality Testing

**Relevant Topic:** IV

**Objectives:**
- To measure and analyze coliform levels, dissolved oxygen (DO), and biochemical oxygen demand (BOD)
- To determine the relationship between DO and BOD
- To measure temperature, total phosphates, nitrates, turbidity and total solids using appropriate water-quality tests
- To compare test results to EPA water-quality standards
- To assess overall water quality

**Resources:** Alexander (DO & BOD only), Enger, Mitchell, Rockett, Stapp

**Materials/Equipment:** Lactose presumptive test kits, BGLB (Brilliant Green Lactose Bile) test kits, EMB (Eosin Methylene Blue) plates, incubator, DO test kit, BOD respirometer, water test kit, Secchi disk, various water samples

### 13. Water/Wastewater Treatment

**Relevant Topic:** IV

**Objectives:**
- To conduct an on-site inspection of a water and/or wastewater treatment facility
- To construct a flow chart from input through the treatment process to output (effluent)
- To explain the function of each treatment phase
- To compare contaminant levels present in raw water or wastewater to those present in the effluent (for example, dissolved and suspended solids, BOD, nitrogen, phosphorous, toxic substances)

**Resources:** Harley, Rockett, The World Resources Institute, Tomera, Wolf

**Materials/Equipment:** Transportation to and from site location, data-collection sheets, IBM computer (or IBM-compatible computer)

### 14. Solid-Waste Management

**Relevant Topic:** IV

**Objectives:**
- To determine the types and amounts of solid waste generated by students and their families
- To compare student data to the US Municipal Solid Waste data
- To conduct an on-site inspection of a municipal solid waste facility
- To identify the method(s) of disposal currently employed in the local municipality
- To evaluate methods of disposal and their effectiveness

**Resources:** Enger, Harley, Rockett, Tomera, Wolf

**Materials/Equipment:** Suitable data sets, data charts, calculator, transportation to and from site location

### 15. The Greenhouse Effect

**Relevant Topic:** V

**Objectives:**
- To construct a model that demonstrates the greenhouse effect
- To explain the greenhouse effect
- To identify the major greenhouse gases and their sources
- To explain the relationship between greenhouse gases and global warming
- To analyze the environmental impact of global warming
- To describe how greenhouse gas emissions may be reduced

**Resources:** Harley, Roa, The World Resources Institute

**Materials/Equipment:** Clear plastic boxes, bottles, or aquaria; plastic wrap or bag, thermometers, cardboard, dark- and light-colored sand or soil, rocks, light source (100 watt or more), IBM computer (or IBM-compatible computer)

### 16. Acid Deposition

**Relevant Topic:** IV

**Objectives:**
- To collect water samples from various sources, such as streams, lakes, ponds, and precipitation (rain or snow)
- To measure pH levels
- To compile pH data over an extended period of time (such as a month)
- To identify sources of pollutants that can affect pH
- To describe ways to reduce the amounts and types of pollutants produced
- To explain the role of the water cycle in acid deposition
- To analyze the relationship between acid deposition and weather patterns

**Resources:** Enger, Harley, Rockett

**Materials/Equipment:** Sample jars, graduated cylinders, wide- and short-range pH paper or pH meter, daily weather maps (e.g., from the newspaper)

### 17. The Effects of Radiation on Growth

**Relevant Topic:** IV

**Objectives:**
- To measure the growth of irradiated and unirradiated seeds
- To graph experimental and control data as a function of time and radiation dose
- To analyze the effects of different amounts of radiation on growth parameters (iq, root and shoot length, germination rates)
- To predict the effects of common radiation exposures and nuclear accidents on plant growth

**Resources:** Enger

**Materials/Equipment:** Irradiated and unirradiated seeds, petri dishes, millimeter rulers

**18. Research Project**

**Relevant Topic:** VI (and possibly others)

**Objectives:**
- To define a local environmental problem
- To design and conduct a field study
- To use appropriate techniques and instrumentation
- To perform appropriate laboratory tests
- To analyze and interpret data
- To identify applicable environmental laws and regulations—local, regional, and federal
- To propose a possible solution(s) to the problem

**Resources:** Jackson, *Regional Environmental Issues Manuals*, Wolf

**Materials/Equipment:** These will vary according to the project—IBM computer or IBM-compatible computer (386 or above) with Windows (3.1), CD-ROM player, sound board with audio speakers, mouse

## Laboratory Resources

The following lists represent a sampling of the types of resources that may be helpful in the development of a laboratory/field investigation program for an AP Environmental Science course. Inclusion of a publication or software package in the lists below does not constitute endorsement by the College Board, ETS, or the AP Environmental Science Development Committee.

### General Resources

Berman, E. Ann. *Exploring the Environment through Satellite Imagery*, Virginia: Tri-Space, Inc., 1994.

> Explains remote sensing and how it is used to analyze weather systems including its applications to oceanography and agriculture; contains remote sensing images and a listing of activities and problems. Multimedia remote sensing products also available in CD-ROM format.

EPA. *Summary of US EPA Approved Methods, Standard Methods and other Guidance for the 301h Monitoring Variables*

GREEN. *Investigating Streams and Rivers: An Interdisciplinary Curriculum Guide for Use with Mitchell and Stapp's Field Manual for Water Quality Monitoring*, Ann Arbor, MI: The Global Rivers Environmental Education Network (GREEN), 1992.

A curriculum guide which includes information on how to participate in the GREEN international computer conference network—EcoNet.

Mitchell, Mark. *Heavy Metals Manual*, Ann Arbor, MI: The Global Rivers Environmental Education Network (GREEN), 1994.

A manual developed for the Great Lakes Basin, however, applicable to other regions; includes chapters on the ecological effects of toxics, heavy metals and human health, sources of pollutants and their distribution, policies and laws regarding toxics, and field monitoring and laboratory techniques.

Mitchell, Mark K., and William B. Stapp. *Field Manual for Water Quality Monitoring*, 9th ed., Dexter, MI: Thomson-Shore Printers, 1995.

A guide to water quality which includes an action-research component and a problem-solving component. Specifics include how to collect, test, analyze and interpret water quality; how to examine water quality in relationship to river systems; and how to develop courses of action to preserve, promote or restore the health of water systems. Copies may be ordered from William B. Stapp, 2050 Delaware Ave., Ann Arbor, Michigan 48103.

New Jersey Department of Environmental Protection and Energy. *Field Sampling Procedures Manual*, 1992.

Although published by the NJDEPE, this manual is based on EPA procedures for the collection, handling and preservation of field samples: water, sediment, micro- and macro-organisms, air, soil, and hazardous wastes.

Project del Rio. *Project del Rio Lesson Plans for a 16-Day Water Quality Monitoring Project*, Ann Arbor, MI: The Global Rivers Environmental Education Network (GREEN), April 1992.

Includes daily lesson plans, guide to the use of watershed, land use, drinking water and sewage water maps, data tables and worksheets, water-quality quiz, equipment list, site survey, problem-solving activities and a list of water-related resources.

*Regional Environmental Issues Manuals*, New York: Saunders College Publishing/Harcourt Brace College Publishers, 1993.

Each of the following manuals specifically addresses regional environmental issues through readings that present various viewpoints, questions and commentary; designed to provide stimulus for further student investigations.

Ambrose, William G., Jr., David B. Knowles, Joseph J. Luczkovich, Paul F. Romp, Barbara Roller, and Donald W. Stanley. *Southeast Regional Environmental Issues Manual* (Tennessee, North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana)

Butler, Jack L., and Cheryl Schmidt. *Midwest Regional Environmental Issues Manual* (North and South Dakota, Iowa, Nebraska, Kansas, Missouri, Arkansas)

Jahoda, John C. *Northeast Regional Environmental Issues Manual* (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York)

Leighton, Tony. *Canadian Regional Environmental Issues Manual*

Naseri, Muthena. *Southwest Regional Environmental Issues Manual* (Southern California, Nevada, Arizona, New Mexico, Utah, Oklahoma, Texas, Hawaii)

Racle, Fred A., Mark R. Luttenton, and Sharon L. Heaney. *Great Lakes Regional Environmental Issues Manual* (Ohio, Indiana, Illinois, Minnesota, Wisconsin, Michigan)

Thomas, Barry. *Northwest Regional Environmental Issues Manual* (Alaska, Washington, Idaho, Oregon, Montana, Wyoming, Colorado, Northern California)

Underwood, Larry. *Mid-Atlantic Regional Environmental Issues Manual* (New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, Kentucky)

Roa, Michael L. *Environmental Science Activities Kit*, West Nyack, NY: The Center for Applied Research on Education, 1993.

A resource book for grades 7-12 with many cooperative learning and open-ended activities, discussion questions as well as a few applicable laboratory activities and extensions designed to require only common materials and equipment. Pages are reproducible and each unit includes a teacher's guide.

Stapp, William B., and Mark K. Mitchell. *Field Manual for Global Low-Cost Water Quality Monitoring*, Dexter, MI: Thomson-Shore Printers, 1995.

A manual designed to supplement the *Field Manual for Water Quality Monitoring* (9th edition) with inexpensive monitoring options. Copies may be ordered from GREEN Office, 721 E. Huron, Ann Arbor, Michigan 48104.

The World Resources Institute. *World Resources 1994-95: A Guide to the Global Environment*, New York: Oxford University Press, 1994.

A reference that provides current accurate information on environment and development; divided into four parts—People and the Environment, Regional Focus (China and India), Conditions and Trends, and Data Tables. A World Resources Data Base IBM or compatible Diskette is available with 503 variables for up to 198 countries, nine regions and two economic groupings, complete with a User's Guide.

Tomera, Audrey N. *Understanding Basic Ecological Concepts*, Portland, ME: J. Weston Walch, 1989.

A basic work text with a few applicable laboratory activities.

### Laboratory Manuals

Alexander, W. Merle, Heidi A. Marcum, and Daniel E. Beams. *Laboratory Manual to Accompany Environmental Science: Action for a Sustainable Future*, 3rd ed., New York: Addison Wesley Longman, Inc., 1991.

A general introductory laboratory manual with 14 laboratory activities that address fundamental concepts of environmental science.

Brower, James E., Jerrold H. Zar, and Carl Von Ende. *Field and Laboratory Methods for General Ecology*, 4th ed., Boston, MA: WCB/McGraw Hill, 1998.

Enger, Eldon D., and Bradley E. Smith. *Field and Laboratory Activities T/A Environmental Science*, McGraw Hill, 1999.

A general manual that emphasizes the interdisciplinary nature of environmental science. The activities are divided into five parts, each prefaced with field-trip suggestions and alternative learning activities. The exercises also include simulation and written research activities as well as experiments.

Gilligan, Matthew, Thomas Kozel, and Joseph Richardson. *Environmental Science Laboratory: a Manual of Lab and Field Exercises*, Savannah, GA: Half Moon Publishing, 1991.

Harley, John P., and Bernard J. Nebel. *Laboratory Manual for Environmental Science: The Way the World Works*, 3rd ed., Englewood Cliffs, NJ: Prentice Hall, 1990.

Includes 28 exercises in three categories—Independent Study, Field Trips, and Indoor Laboratory.

Rockett, C. Lee, and Kenneth J. Van Dellen. *Laboratory Manual for Miller's Living in the Environment*, *Environmental Science and Sustaining the Earth*, Belmont, CA: Wadsworth Publishing Company, 1993.

Biological emphasis; includes 20 activities—laboratory and workbook exercises designed to require a minimum of sophisticated equipment.

Rosenthal, Dorothy B. *Environmental Science Activities*, New York: John Wiley and Sons, 1995.

Wolf, Robert J., Calvin B. DeWitt, Karen Jankowski, and Gerrit VanDyke. *Environmental Science in Action*, New York: Saunders College Publishing/Harcourt Brace College Publishers, 1993.

A general manual addressing 20 topics, primarily through field trips and written exercises; minimal equipment is required. Note: more than half of this manual is devoted to blank lined pages for the student's notes.

### Software Packages

Anderson, Thomas, and Tue Albertson. *Geodynamics Database* (IBM, Windows, CD-ROM), EME Corporation, Stuart, FL.

> Includes multimedia visuals, maps, cross-sectional topographical maps and a data base for over 1,500 volcanoes and 89,000 earthquakes. Students can investigate plate boundaries, relationships between volcanoes and earthquakes and plate tectonics. User's guide includes student laboratory activities and advanced activities.

Lopez, Gary. *Population Concepts* (IBM), Danbury, CT: EME Corporation, 1994.

> An interactive computer simulation which includes an "Introduction" with basic information on population dynamics and an "Experimental Mode" that sets up and runs population experiments allowing students to alter variables such as reproductive rate, initial population, and carrying capacity. Package includes an IBM disc, a study guide, and student work booklets.

Jackson, Jim, John Hirschbuhl, and Dwight Bishop. *Environmental Science: Field Laboratory* (IBM, Windows, CD-ROM), Wellesley, MA: Falcon Software, Inc., 1995.

> Field studies simulation based on actual field studies—students collect and evaluate real data and write a final report; the program records student progress, including performance, post-test scores and final essay. Module topics include: Stream Pollution, Legal Control of the Environment, Geology of Homesite Selection, Minerals for Society, Radiation in the Environment, Energy from Coal, and Streams and Floods.

Rosenzweig, Cynthia, and George Ropes. "Hothouse Planet," *Focus on Environment*, Danbury, CT: EME Corporation, 1995.

> Primarily a simulation model but does include actual data on volcanic eruptions and corresponding temperature changes. Student activities sheet includes a section on "Volcanoes and Climate."

## Instructional Issues: Training, Funding, and Scheduling

An AP course is a college course, and the resources and time allotted should be similar to those in a college course. Because AP Environmental Science includes substantial material from both the life sciences and the physical sciences, it is likely that many schools will not have a single teacher whose background is adequate preparation for them to teach the entire course. In these situations, teachers should seek the expertise of their colleagues, either by team teaching, using guest lecturers, or making frequent consultations with colleagues and outside experts.

School administrators should be aware that an AP college-level science course is significantly more expensive to operate than a typical high school course and requires more scheduled time than courses without laboratory work. The introductory level college science course typically consists of between 40 and 50 hours of lecture and between 30 and 40 hours of laboratory work per quarter or semester. Proportional allocations of time for class and laboratory work should be accorded an AP Environmental Science course. School administrators should provide the equivalent of two double periods a week to allow for laboratory/field work.

Some of the laboratory/field investigations will require equipment the school may not already have. Schools may find it possible to share equipment that belongs to other high schools or to community colleges, but should plan to purchase college-level laboratory equipment eventually.

## The Examination

The AP Environmental Science Examination is three hours long and is divided equally in time between a multiple-choice section and a free-response section. The multiple-choice section, which constitutes 60 percent of the final grade, consists of 100 multiple-choice questions that are designed to cover the breadth of the students' knowledge and understanding of environmental science. Thought-provoking problems and questions based on fundamental ideas from environmental science are included along with questions based on the recall of basic facts and major concepts. The number of multiple-choice questions taken from each major topic area is reflected in the percentage of the course as designated in the topic outline (see pages 5-8).

The free-response section emphasizes the application of principles in greater depth. In this section, students must organize answers to broad questions, thereby demonstrating reasoning and analytical skills, as well

as the ability to synthesize material from several sources into cogent and coherent essays. Four free-response questions are included in this section, which constitutes 40 percent of the final grade: one data-set question, one document-based question, and two synthesis and evaluation questions. Questions from the 2000 exam appear on pages 32-35.

In order to provide maximum information about differences in students' achievements in environmental science, the examination is designed to yield average scores of about 50 percent of the maximum possible scores for both the multiple-choice and free-response sections. Thus, students should be aware that they may find these examinations more difficult than most classroom examinations. However, it is possible for students who have studied most but not all topics in the outline to obtain acceptable grades.

The use of calculators is not allowed on either section of the examination.

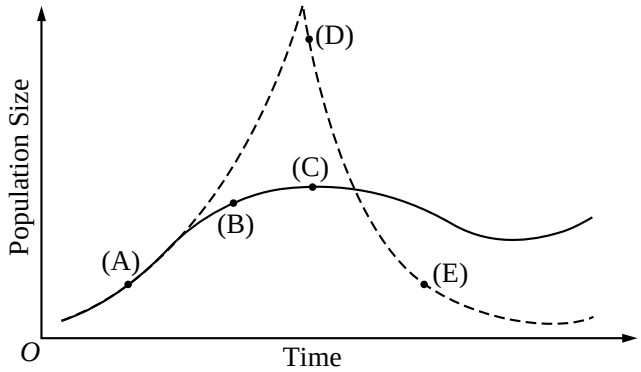
## Sample Multiple-Choice Questions

The following are examples of the kinds of multiple-choice questions found on the AP Environmental Science Exam. The distribution of topics and range of difficulty are illustrative of the composition of the exam. Students should spend an average time of less than one minute on each multiple-choice question, since 90 minutes are allotted for answering 100 questions.

Students often ask whether they should guess on multiple-choice questions. Haphazard or random guessing is unlikely to improve scores, because one-fourth of the number of questions answered incorrectly will be subtracted from the number of questions answered correctly. However, candidates who have some knowledge of a question and can eliminate one or more answer choices will usually find it advantageous to guess from among the remaining choices. An answer key to the multiple-choice questions can be found on page 31.

*Directions:* The lettered choices on the graph below refer to the numbered statements immediately following it. Select the one lettered choice that best fits each statement. Each choice may be used once, more than once, or not at all in each set.

Questions 1–3 refer to the lettered points of the curves plotted on the graph below. The curves show two possible patterns of change in population size over time for a certain species of small mammal in an ecosystem.




1. Population growing exponentially

2. Population decreasing at greatest rate

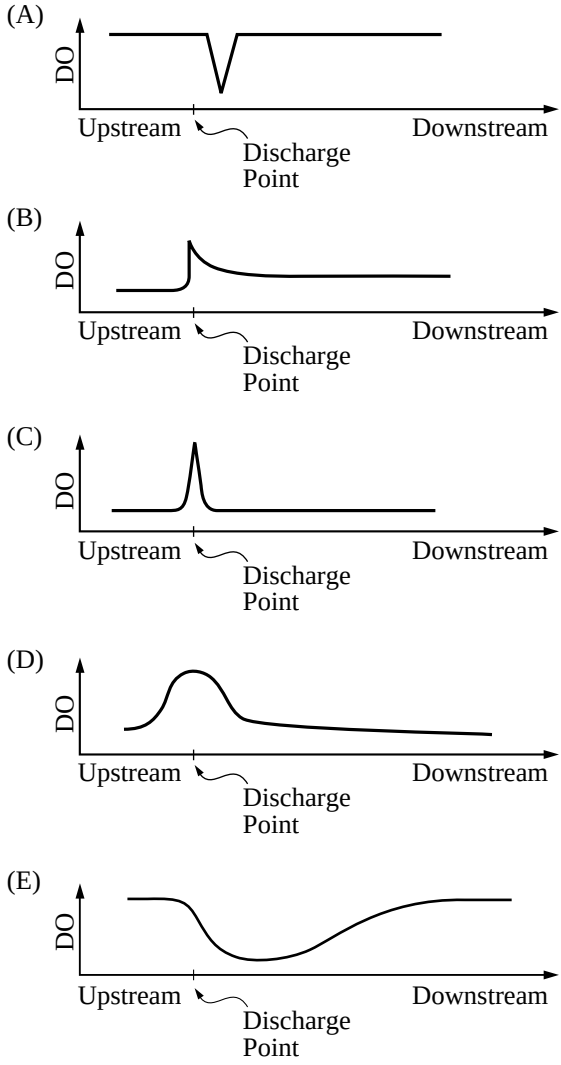
3. Population growing at a decreasing rate

*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.

4. Which of the following is LEAST likely to be an effect of global warming?
   (A) Loss of fertile delta regions for agriculture
   (B) Change in global patterns of precipitation
   (C) Extinction of some species that have narrow temperature requirements
   (D) Decreased rate of photosynthesis in vegetation
   (E) Increased frequency of hurricanes

5. When $X$ joules of nuclear energy is used to produce $Y$ joules of electrical energy, which of the following is true?
   (A) In every case, $X > Y$
   (B) In every case, $X = Y$
   (C) In every case, $X < Y$
   (D) Either $X < Y$ or $X > Y$, depending on the efficiency of the generator
   (E) Either $X < Y$ or $X > Y$, depending on the amount of heat produced

6. A point source discharges organic waste into a stream. Which of the following graphs best depicts the expected pattern for dissolved oxygen (DO) in this stream as a function of distance from the discharge point?



7. Of the following, which has the greatest permeability?
   (A) Clay
   (B) Loam
   (C) Sand
   (D) Silt
   (E) Humus

8. Reasons that the population size of an exotic species often grows rapidly when the species is introduced in a new environment include which of the following?

   I. The exotic species is resistant to pesticides.
   II. There is a large, underutilized food source in the new environment.
   III. The exotic species has few natural predators in the new environment.

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

9. Most of the Earth's deserts are at approximately 30° latitude, north and south, because these latitudes are characterized by
   (A) generally warm ocean currents
   (B) predominantly low atmospheric pressure
   (C) descending dry air currents
   (D) slow-moving jet streams
   (E) enhanced solar radiation

10. The presence of which of the following contaminants would be the strongest reason for judging municipal sewage sludge unfit for use as fertilizer?
   (A) Human feces
   (B) Ammonia
   (C) Phosphates
   (D) Nitrates
   (E) Heavy metals

11. Which of the following is the best example of environmental remediation?
    (A) A species of trout becomes extinct in a eutrophic lake.
    (B) The annual volume of sewage flowing into a stream is decreased by one half.
    (C) The height of a factory smokestack is increased.
    (D) A parcel of forest land is declared a state park.
    (E) PCB-consuming bacteria are sprayed on an area that has soil contaminated with PCB's.

12. The CITES treaty has been helpful in protecting endangered animals and plants by
    (A) listing all species that can be hunted, traded, and used commercially
    (B) listing those species and products whose international trade is controlled
    (C) funding projects for breeding endangered plants and animals
    (D) preventing the hunting of whales and dolphins
    (E) specifying prices for certain plant and animal products

13. A country currently has a population of 100 million and an annual growth rate of 3.5 percent. If the growth rate remains constant, what will be the population of this country in 40 years?
    (A) 150 million
    (B) 200 million
    (C) 300 million
    (D) 400 million
    (E) 800 million

14. The dangers of disposing of toxic chemicals underground came to public attention in which of the following locations?
    (A) Bhopal, India
    (B) Chernobyl, Ukraine
    (C) Love Canal, New York
    (D) Minamata, Japan
    (E) Three Mile Island, Pennsylvania

15. Which type of electricity-generating power plant releases radioactive materials as well as toxic metals such as lead and arsenic under normal operating conditions?
    (A) Nuclear
    (B) Hydroelectric
    (C) Solar
    (D) Coal-burning
    (E) Geothermal

16. Which of the following greenhouse gases has the greatest heat-trapping ability per molecule?
    (A) Carbon dioxide
    (B) Carbon monoxide
    (C) Chlorofluorocarbon
    (D) Methane
    (E) Nitrous oxide

17. Of the following, the greatest threat to populations of migratory North American songbirds is
    (A) predation by raptors
    (B) clearing of tropical forests
    (C) disease from polluted waters
    (D) sport hunting
    (E) international trade in pets

**Answers to Multiple-Choice Questions**

| | | | | | |
|---|---|---|---|---|---|
| 1 – A | 4 – D | 7 – C | 10 – E | 13 – D | 16 – C |
| 2 – D | 5 – A | 8 – D | 11 – E | 14 – C | 17 – B |
| 3 – B | 6 – E | 9 – C | 12 – B | 15 – D | |

## Sample Free-Response Questions

The free-response section of the examination consists of four required questions: one data-set question, one document-based question, and two synthesis and evaluation questions. The following questions appeared on the 2000 exam. Additional sample questions can be found in the AP section of the College Board Web site.

1. A large, coal-fired electric power plant produces 12 million kilowatt-hours of electricity each day. Assume that an input of 10,000 BTU's of heat is required to produce an output of 1 kilowatt-hour of electricity.

   (a) Showing all steps in your calculations, determine the number of
   (i) BTU's of heat needed to generate the electricity produced by the power plant each day,
   (ii) pounds of coal consumed by the power plant each day, assuming that one pound of coal yields 5,000 BTU's of heat,
   (iii) pounds of sulfur released by the power plant each day, assuming that the coal contains one percent sulfur by weight.

   (b) The Environmental Protection Agency (EPA) standard for power plants such as this one is that no more than 1.2 pounds of sulfur be emitted per million BTU's of heat generated. Using the results in part (a), determine whether the power plant meets the EPA standard.

   (c) Describe two ways by which a fuel-burning electric power plant can reduce its sulfur emissions.

   (d) Discuss why sulfur emissions from coal-fired power plants are considered an environmental problem and describe one negative effect on an ecosystem that has been associated with sulfur emissions.

2. After reading the following editorial from *The Fremont Daily*, answer the questions that follow.

IS RECYCLING SMART ECONOMICS?

Debates about recycling often become highly charged and passionate. Over the past decade some headlines have heralded that "trash is treasure" while others have proclaimed that "recycling is garbage."

The antagonists in these debates are disagreeing over public policy and its role in shaping decisions about resource use. Both sides in these debates frequently have broad policy agendas that go far beyond choosing the most efficient way to manage solid waste. Both sides also promote their political agendas with unsupported assertions and incomplete information. Determining what amount of recycling will result in efficient resource use requires systematic analysis.

Proponents of recycling argue that recycling saves resources. For example, most manufacturers of aluminum cans currently depend on recycled aluminum for more than 50% of their needs. This recycled input reduces the economic and environmental costs associated with mining and landfills.

A common argument for the antirecycling side is that recycling wastes resources. It takes resources to recycle. For example, it takes human effort to sort aluminum cans from other trash and energy to move aluminum cans from the consumer back to the manufacturer.

It may not make economic sense to recycle all materials or all of any single material, but numerous studies have shown that there are net benefits to society at low or modest levels of recycling most materials. The question is, Which has the higher environmental cost: using recovered materials or using virgin materials? Do recovered or virgin materials cost more in resources? The answer is complex and changing.

Your next environmental decision is fast approaching. Should you put this copy of *The Fremont Daily* in the recycling bin or should you put it in the trash?

(a) Consider the arguments regarding aluminum presented in the editorial, then make
   (i) a similar argument in favor of recycling the newspaper, and
   (ii) a similar argument against recycling the newspaper.

(b) For each of the following, describe <u>two</u> pieces of scientific information that would be needed to evaluate
   (i) the environmental benefits of recycling the newspaper, and
   (ii) the environmental costs of recycling the newspaper.

(c) If a community can afford to begin a recycling program for either aluminum or newspaper, but not both, which one would you recommend to be recycled? Provide two reasons why your recommendation is better than the alternative.

(d) Discuss two difficulties that the community might face in implementing the recycling program in part (c).

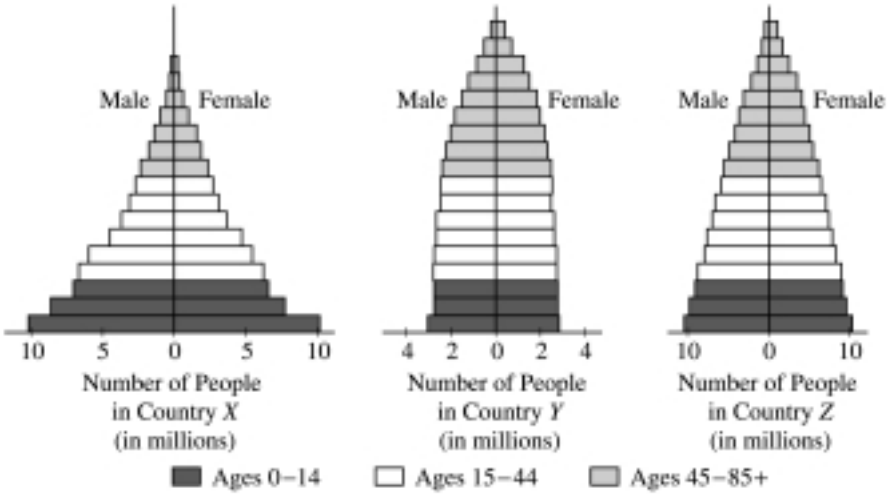
3. Species such as the dusky seaside sparrow, the passenger pigeon, and the woolly mammoth are extinct. Populations of other species have declined to the point where they are designated as threatened or endangered.

   (a) Identify one threatened or endangered species and explain why its population has declined.

   (b) Describe three characteristics of organisms that would make them particularly vulnerable to extinction.

   (c) Present three arguments in favor of the maintenance of biodiversity.

   (d) Name and describe one United States federal law or one international treaty that is intended to prevent the extinction of species.




4. The figures above show the age structures of human populations in three countries, *X*, *Y* and *Z*.

   (a) Which of the three countries has the largest rate of population growth? Which has the smallest rate? Explain.

   (b) Compare the infant mortality rates that are likely in Countries *X* and *Y*. Explain your reasoning.

   (c) Describe the changes in both the birth rate and the death rate for a country making the transition from a preindustrial society to an industrial society.

   (d) Describe one incentive that the government of a country could offer its citizens that would favor a reduction in the growth rate of its population. Explain how this incentive would work, and describe one possible drawback.

# AP Program Essentials

## The AP Reading

In June, the free-response sections of the exams, as well as the portfolios in Studio Art, are scored by college and secondary school teachers at the AP Reading. Thousands of these faculty consultants participate, under the direction of a Chief Faculty Consultant in each field. The experience offers both significant professional development and the opportunity to network with like-minded educators; if you are an AP teacher or a member of a college faculty and would like to serve as a faculty consultant, you can apply online in the AP section of the College Board's Web site. Alternatively, send an e-mail message to apreader@ets.org, or call Performance Scoring Services at 609 406-5383.

### AP Grades

The faculty consultants' judgments on the essay and problem-solving questions are combined with the results of the computer-scored multiple-choice questions, and the total raw scores are converted to AP's 5-point scale:

| AP GRADE | QUALIFICATION |
|---|---|
| 5 | Extremely Well Qualified |
| 4 | Well Qualified |
| 3 | Qualified |
| 2 | Possibly Qualified |
| 1 | No Recommendation |

### Grade Distributions

Many teachers want to compare their students' grades with the national percentiles. Grade distribution charts are available in the subject pages of the AP Web site, as is information on how the cut-off points for each AP grade are calculated.

## AP and College Credit

Advanced placement and/or credit is awarded by the college or university, not the College Board or the AP Program. The best source of specific and up-to-date information about an individual institution's policy is its catalog or Web site.

## Why Colleges Give Credit for AP Grades

Colleges need to know that the AP grades they receive for their incoming students represent a level of achievement equivalent to that of students who take the same course in the colleges' own classrooms. That equivalency is assured through several Advanced Placement Program processes:

- College faculty serve on the committees that develop the course descriptions and examinations in each AP subject.
- College faculty are responsible for standard setting and are involved in the evaluation of student responses at the AP Reading.
- AP courses and exams are updated regularly, based on both the results of curriculum surveys at up to 200 colleges and universities and the interactions of committee members with professional organizations in their discipline.
- College comparability studies are undertaken in which the performance of college students on AP Exams is compared with that of AP students to confirm that the AP grade scale of 1–5 is properly aligned with current college standards.

In addition, the College Board has commissioned studies that use a "bottom-line" approach to validating AP Exam grades by comparing the achievement of AP versus non-AP students in higher-level college courses. For example, in the 1998 Morgan and Ramist "21-College" study, AP students who were exempted from introductory courses and who completed a higher-level course in college are compared, on the basis of their college grades, with students who completed the prerequisite first course in college, then took the second, higher-level course in the subject area. Such studies answer the question of greatest concern to colleges — are their AP students who are exempted from introductory courses as well prepared to continue in a subject area as students who took their first course in college? To see the results of several college validity studies, go to the AP pages of the College Board's Web site. (The aforementioned Morgan and Ramist study can be downloaded from the site in its entirety.)

## Guidelines on Granting Credit for AP Grades

If you are an admission administrator and need guidance on setting a policy for your college, you will find the *College and University Guide to the Advanced Placement Program* useful; see the back of this booklet for ordering information. Alternatively, contact your local College Board Regional Office, as noted on the inside back cover of this booklet.

### Finding Colleges That Accept AP Grades

In addition to contacting colleges directly for their AP policies, students and teachers can use College Search, an online resource maintained by the College Board through its Annual Survey of Colleges. College Search can be accessed via the College Board's Web site (www.collegeboard.com). It is worth remembering, though, that policies are subject to change. Contact the college directly to get the most up-to-date information.

## AP Scholar Awards and the AP International Diploma

The AP Program offers a number of awards to recognize high school students who have demonstrated college-level achievement through AP courses and exams. In addition, the AP International Diploma (APID) certifies the achievement of successful AP candidates who plan to apply to a university outside the United States.

For detailed information on AP Scholar Awards and the APID, including qualification criteria, visit the AP Web site or contact the College Board's National Office. Students' questions are also answered in the *AP Bulletin for Students and Parents*; information about ordering and downloading the *Bulletin* can be found at the back of this booklet.

## AP Calendar

To get an idea of the various events associated with running an AP program and administering the AP Exams, please refer to this year's edition of *A Guide to the Advanced Placement Program*; information about ordering and downloading the *Guide* can be found at the back of this booklet.

## Test Security

The entire AP Exam must be kept secure until the scheduled administration date. Except during the actual exam administration, exam materials must be placed in locked storage. Forty-eight hours after the exam has been administered, the green and blue inserts from the free-response section (Section II) are available for teacher and student review.* **However, the multiple-choice section (Section I) must remain secure both before and after the exam administration.** No one other than candidates taking

*The alternate (make-up) form of the free-response section is NOT released.

the exam can ever have access to or see the questions contained in this section — this includes AP Coordinators and AP teachers. The multiple-choice section must never be shared or copied in any manner.

Various combinations of selected multiple-choice questions are reused from year to year to provide an essential method of establishing high exam reliability, controlled levels of difficulty, and comparability with earlier exams. These goals can only be attained when the multiple-choice questions remain secure. This is why teachers cannot view the questions and students cannot share information about these questions with anyone following the exam administration.

To ensure that all students have an equal chance to perform on the exam, AP Exams must be administered in a uniform manner. **It is extremely important to follow the administration schedule and all procedures outlined in detail in the most recent *AP Coordinator's Manual*.** The manual also includes directions on how to deal with misconduct and other security problems. Any breach of security should be reported immediately through the test security hot line (call 800 353-8570, e-mail tsreturns@ets.org, or fax 609 406-9709).

## Teacher Support

Look for these enhanced Web resources at www.collegeboard.com/ap

- Information about AP Exam development, administration, scoring and grading, fees, and scheduling.
- Program news, such as exam format changes, opinion polls (teacher surveys, ad hoc polls), and profiles of successful teachers and AP programs.
- A searchable catalog of teaching resources, including: course topic outlines, sample syllabi and lesson plans, strategies and tips, topic briefs, links, and textbook reviews.
- A searchable catalog of professional development opportunities (e.g., workshops, summer institutes, conferences). New and experienced AP teachers are invited to attend workshops and institutes to learn the fundamentals of teaching an AP course, as well as the latest expectations for each course and exam. Sessions ranging from one day to three weeks in length are held year-round. Dates, locations, topics, and fee information are also available through the College Board's Regional Offices.

- Online forums for exchanging ideas with AP teachers.
- Sample multiple-choice and free-response questions.

To supplement these online resources, there are a number of AP publications, CD-ROMs, and videos that can assist AP teachers. Please see the following pages for an overview and for ordering information.

## Pre-AP™

### Preparing Students for Challenging Courses; Preparing Teachers for Student Success

Pre-AP has two objectives: (1) to promote access to AP for all students; (2) to provide professional development through content-specific strategies to build a rigorous curriculum. Teachers employ Pre-AP strategies and materials to introduce skills, concepts, and assessment methods that prepare students for success when they take AP and other challenging academic courses. Schools use Pre-AP strategies to strengthen and align the curriculum across grade levels, and to increase the academic challenge for all students.

Pre-AP professional development is available to teachers through Building Success workshops and through AP Vertical Teams™ conferences and workshops.

- **Building Success** is a two-day workshop that assists English and history teachers in designing curricula for grade 7 and above. Teachers learn strategies to help students engage in active questioning, analysis, and constructing arguments. Workshop topics include assessment, interdisciplinary teaching and learning, and vertical planning.
- **AP Vertical Teams** are trained via one-day workshops, two-day conferences, and five-day summer institutes; they enable middle school and high school teachers to prepare Pre-AP students for academic success in AP courses and in college. Topics include organizing effective teams, aligning curricula, and developing content-specific teaching strategies.
- **Setting the Cornerstones: Building the Foundation of AP Vertical Teams** is a two-day workshop designed to provide information about the College Board and the AP Program, and to suggest strategies for establishing coherence, commitment, collegiality, and collaboration among the members of an AP Vertical Team.

For more information about Building Success workshops and for schedules of AP Vertical Teams workshops and conferences, contact your College Board Regional Office. Alternatively, contact Mondy Raibon, Pre-AP Initiatives, AP Program, The College Board, 45 Columbus Avenue, New York, NY 10023-6992; 212 713-8156; mraibon@collegeboard.org.

## AP Publications and Other Resources

A number of AP publications, CD-ROMs, and videos are available to help students, parents, AP Coordinators, and high school and college faculty learn more about the AP Program and its courses and exams. To identify resources that may be of particular use to you, refer to the following key.

| | | | |
|---|---|---|---|
| **Students and Parents** | **SP** | **AP Coordinators and Administrators** | **A** |
| **Teachers** | **T** | **College Faculty** | **C** |

### Ordering Information

You have several options for ordering publications:

- **Online.** Visit the College Board store to see descriptions and pictures of AP publications and to place your order.
- **By mail.** Send a completed order form with your payment or credit card information to: Advanced Placement Program, Dept. E-06, P.O. Box 6670, Princeton, NJ 08541-6670. If you need a copy of the order form, you can download one from the AP Library (www.collegeboard.com/ap/library).
- **By fax.** Credit card orders can be faxed to AP Order Services at 609 771-7385.
- **By phone.** Call AP Order Services at 609 771-7243, Monday through Friday 8:00 a.m. to 9:00 p.m., and Saturday 9:00 a.m. to 4:45 p.m. ET. Have your American Express, MasterCard, or VISA information ready. This phone number is for credit card orders only.

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## Print

Items marked with a computer mouse icon can be downloaded for free from the AP Library (www.collegeboard.com/ap/library).

**AP Bulletin for Students and Parents: Free** **SP**

This bulletin provides a general description of the AP Program, including policies and procedures for preparing to take the exams, and registering for the AP courses. It describes each AP Exam, lists the advantages of taking the exams, describes the grade reporting and award options available to students, and includes the upcoming exam schedule.

**College and University Guide to the AP Program: $10** **C, A**

This guide is intended to help college and university faculty and administrators understand the benefits of having a coherent, equitable AP policy. Topics included are validity of AP grades; developing and maintaining scoring standards; ensuring equivalent achievement; state legislation supporting AP; and quantitative profiles of AP students by each AP subject.

**Course Descriptions: $12** **SP, T, A, C**

Course Descriptions provide an outline of the AP course content, explain the kinds of skills students are expected to demonstrate in the corresponding introductory college-level course, and describe the AP Exam. They also provide sample multiple-choice questions with an answer key, as well as sample free-response questions. A complete set of Course Descriptions is available for $100.

**A Guide to the Advanced Placement Program: Free** **A**

Written for both administrators and AP Coordinators, this guide is divided into two sections. The first section provides general information about AP, such as how to organize an AP program at your high school, the kind of training and support that is available for AP teachers, and a look at the AP Exams and grades. The second section contains more specific details about testing procedures and policies and is intended for AP Coordinators.

**Interpreting and Using AP Grades: Free** **A, C, T**

A booklet containing information on the development of scoring standards, the AP Reading, grade-setting procedures, and suggestions on how to interpret AP grades.

**Pre-AP: Achieving Equity, Emphasizing Excellence: Free** **A, T**

An informational brochure describing the Pre-AP concept and outlining the characteristics of a successful Pre-AP program.

**Released Exams: $20**
**($30 for "double" subjects: Calculus, Computer Science, Latin, Physics)** **T**

About every four years, on a staggered schedule, the AP Program releases a complete copy of each exam. In addition to providing the multiple-choice questions and answers, the publication describes the process of scoring the free-response questions and includes examples of students' actual responses, the scoring standards, and commentary that explains why the responses received the scores they did.

*Packets of 10: $30.* For each subject with a released exam, you can purchase a packet of 10 copies of that year's exam for use in your classroom (e.g., to simulate an AP Exam administration).

**Secondary School Guide to the AP Program: $10** **A, T**

This guide is a comprehensive consideration of the AP Program. It covers topics such as developing or expanding an AP program; gaining faculty, administration, and community support; AP Grade Reports, their use and interpretation; AP Scholar Awards; receiving college credit for AP; AP teacher training resources; descriptions of successful AP programs in nine schools around the country; and "Voices of Experience," a collection of ideas and tips from AP teachers and administrators.

**Student Guides**
**(available for Calculus, English, and U.S. History): $12** **SP**

These are course and exam preparation manuals designed for high school students who are thinking about or taking a specific AP course. Each guide answers questions about the AP course and exam, suggests helpful study resources and test-taking strategies, provides sample questions with answers, and discusses how the free-response questions are scored.

**Teacher's Guides: $12** **T**

For those about to teach an AP course for the first time, or for experienced AP teachers who would like to get some fresh ideas for the classroom, the Teacher's Guide is an excellent resource. Each Teacher's Guide contains syllabi developed by high school teachers currently teaching the AP course and college faculty who teach the equivalent course at colleges and universities. Along with detailed course outlines and innovative teaching tips, you'll also find extensive lists of recommended teaching resources.

**AP Vertical Team Guides** **T, A**

An AP Vertical Team (APVT) is made up of teachers from different grade levels who work together to develop and implement a sequential curriculum in a given discipline. The team's goal is to help students acquire the skills necessary for success in AP. To help teachers and administrators who are interested in establishing an APVT at their school, the College Board has published three guides: *AP Vertical Teams in Science, Social Studies, Foreign Language, Studio Art, and Music Theory: An Introduction* ($12); *A Guide for Advanced Placement English Vertical Teams* ($10); and *Advanced Placement Program Mathematics Vertical Teams Toolkit* ($35). A discussion of the English Vertical Teams guide, and the APVT concept, is also available on a 15-minute VHS videotape ($10).

## Multimedia

**EssayPrep®** **SP, T**

EssayPrep is available through the AP subject pages of the College Board's Web site. Students can select an essay topic, type a response, and get an evaluation from an experienced reader. The service is offered for the free-response portions of the AP Biology, English Language and Composition, English Literature and Composition, and U.S. History Exams. The fee is $15 per response for each evaluation. SAT® II: Writing Subject Test topics are also offered for a fee of $10. Multiple evaluations can be purchased at a 10–20% discount.

**APCD®: $49 (home version),**
**$450 (multi-network site license)** **SP, T**

These CD-ROMs are available for Calculus AB, English Language, English Literature, European History, Spanish Language, and U.S. History. They each include actual AP Exams, interactive tutorials, and other features including exam descriptions, answers to frequently asked questions, study-skill suggestions, and test-taking strategies. There is also a listing of resources for further study and a planner to help students schedule and organize their study time.

**Videoconference Tapes: $15** **SP, T, C**

AP has conducted live, interactive videoconferences for various subjects, enabling AP teachers and students to talk directly with the Development Committees that design and develop the AP courses and exams. Tapes of these events are available in VHS format and are approximately 90 minutes long.

**AP: Pathway to Success**
**(video — available in English and Spanish): $15** **SP, T, A, C**

This 25-minute video takes a look at the AP Program through the eyes of people who know AP: students, parents, teachers, and college admission staff. They answer such questions as: "Why do it?" "Who teaches AP courses?" and "Is AP for you?" College students discuss the advantages they gained through taking AP courses, such as academic self-confidence, improved writing skills, and college credit. AP teachers explain what the challenge of teaching AP courses means to them and their school, and admission staff explain how they view students who have stretched themselves by taking AP Exams. There is also a discussion of the impact that an AP program has on an entire school and its community, and a look at resources available to assist AP teachers, such as regional workshops, teacher conferences, and summer institutes.

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*2003 Exam Date: Wednesday, May 14, afternoon session*

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