CollegeBoard AP

ENVIRONMENTAL SCIENCE

Course Description

Effective Fall 2010

AP Course Descriptions are updated regularly. Please visit AP Central® (apcentral.collegeboard.com) to determine whether a more recent Course Description PDF is available.

The College Board

The College Board is a not-for-profit membership association whose mission is to connect students to college success and opportunity. Founded in 1900, the association is composed of more than 5,600 schools, colleges, universities, and other educational organizations. Each year, the College Board serves seven million students and their parents, 23,000 high schools, and 3,800 colleges through major programs and services in college admissions, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT®, the PSAT/NMSQT®, and the Advanced Placement Program® (AP®). The College Board is committed to the principles of excellence and equity, and that commitment is embodied in all of its programs, services, activities, and concerns.

For further information visit www.collegeboard.com.

The College Board and the Advanced Placement Program encourage teachers, AP Coordinators, and school administrators to make equitable access a guiding principle 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. All students who are willing to accept the challenge of a rigorous academic curriculum should be considered for admission to AP courses. The Board encourages the elimination of barriers that restrict access to AP courses for students from ethnic, racial, and socioeconomic groups that have been traditionally underrepresented in the AP Program. Schools should make every effort to ensure that their AP classes reflect the diversity of their student population.

Contents

Welcome to the AP® Program

For over 50 years, the College Board's Advanced Placement Program (AP) has partnered with colleges, universities, and high schools to provide students with the opportunity to take college-level course work and exams while still in high school. Offering more than 30 different subjects, each culminating in a rigorous exam, AP provides motivated and academically prepared students with the opportunity to earn college credit or placement and helps them stand out in the college admissions process. Taught by dedicated, passionate AP teachers who bring cutting-edge content knowledge and expert teaching skills to the classroom, AP courses help students develop the study skills, habits of mind, and critical thinking skills that they will need in college.

AP is accepted by more than 3,600 colleges and universities worldwide for college credit, advanced placement, or both on the basis of successful AP Exam grades. This includes over 90 percent of four-year institutions in the United States.

More information about the AP Program is available at the back of this Course Description and at AP Central®, the College Board's online home for AP teachers (apcentral.collegeboard.com). Students can find more information at the AP student site (www.collegeboard.com/apstudents).

AP Courses

More than 30 AP courses in a wide variety of subject areas are now available. A committee of college faculty and master AP teachers designs each AP course to cover the information, skills, and assignments found in the corresponding college course.

AP Exams

Each AP course has a corresponding exam that participating schools worldwide administer in May. Except for AP Studio Art, which is a portfolio assessment, each AP Exam contains a free-response section (essays, problem solving, oral responses, etc.) as well as multiple-choice questions.

Written by a committee of college and university faculty and experienced AP teachers, the AP Exam is the culmination of the AP course and provides students with the opportunity to earn credit and/or placement in college. Exams are scored by college professors and experienced AP teachers using scoring standards developed by the committee.

AP Course Audit

The intent of the AP Course Audit is to provide secondary and higher education constituents with the assurance that an "AP" designation on a student's transcript is credible, meaning the AP Program has authorized a course that has met or exceeded the curricular requirements and classroom resources that demonstrate the academic rigor of a comparable college course. To receive authorization from the College Board to label a course "AP," teachers must participate in the AP Course Audit. Courses authorized to use the "AP" designation are listed in the AP Course Ledger made available to colleges and universities each fall. It is the school's responsibility to ensure that its AP Course Ledger entry accurately reflects the AP courses offered within each academic year.

The AP Program unequivocally supports the principle that each individual school must develop its own curriculum for courses labeled “AP.” Rather than mandating any one curriculum for AP courses, the AP Course Audit instead provides each AP teacher with a set of expectations that college and secondary school faculty nationwide have established for college-level courses. AP teachers are encouraged to develop or maintain their own curriculum that either includes or exceeds each of these expectations; such courses will be authorized to use the “AP” designation. Credit for the success of AP courses belongs to the individual schools and teachers that create powerful, locally designed AP curricula.

Complete information about the AP Course Audit is available at www.collegeboard.com/apcourseaudit.

AP Reading

AP Exams—with the exception of AP Studio Art, which is a portfolio assessment—consist of dozens of multiple-choice questions scored by machine, and free-response questions scored at the annual AP Reading by thousands of college faculty and expert AP teachers. AP Readers use scoring standards developed by college and university faculty who teach the corresponding college course. The AP Reading offers educators both significant professional development and the opportunity to network with colleagues. For more information about the AP Reading, or to apply to serve as a Reader, visit apcentral.collegeboard.com/readers.

AP Exam Grades

The Readers’ scores on the free-response questions are combined with the results of the computer-scored multiple-choice questions; the weighted raw scores are summed to give a composite score. The composite score is then converted to a grade on AP’s 5-point scale:

AP GRADE	QUALIFICATION
5	Extremely well qualified
4	Well qualified
3	Qualified
2	Possibly qualified
1	No recommendation

AP Exam grades of 5 are equivalent to A grades in the corresponding college course. AP Exam grades of 4 are equivalent to grades of A–, B+, and B in college. AP Exam grades of 3 are equivalent to grades of B–, C+, and C in college.

Credit and Placement for AP Grades

Thousands of four-year colleges grant credit, placement, or both for qualifying AP Exam grades because these grades represent a level of achievement equivalent to that of students who have taken the corresponding college course. This college-level equivalency is ensured through several AP Program processes:

- College faculty are involved in course and exam development and other AP activities. Currently, college faculty:
  - Serve as chairs and members of the committees that develop the Course Descriptions and exams in each AP course.
  - Are responsible for standard setting and are involved in the evaluation of student responses at the AP Reading. The Chief Reader for each AP subject is a college faculty member.
  - Lead professional development seminars for new and experienced AP teachers.
  - Serve as the senior reviewers in the annual AP Course Audit, ensuring AP teachers' syllabi meet the curriculum guidelines of college-level courses.
- AP courses and exams are reviewed and updated regularly based on the results of curriculum surveys at up to 200 colleges and universities, collaborations among the College Board and key educational and disciplinary organizations, and the interactions of committee members with professional organizations in their discipline.
- Periodic 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 to 5 is properly aligned with current college standards.

For more information about the role of colleges and universities in the AP Program, visit the Higher Ed Services section of the College Board Web site at professionals .collegeboard.com/higher-ed.

Setting Credit and Placement Policies for AP Grades

The College Board Web site for education professionals has a section specifically for colleges and universities that provides guidance in setting AP credit and placement policies. Additional resources, including links to AP research studies, released exam questions, and sample student responses at varying levels of achievement for each AP Exam are also available. Visit professionals.collegeboard.com/higher-ed/placement/ap.

The "AP Credit Policy Info" online search tool provides links to credit and placement policies at more than 1,000 colleges and universities. This tool helps students find the credit hours and/or advanced placement they may receive for qualifying exam grades within each AP subject at a specified institution. AP Credit Policy Info is available at www.collegeboard.com/ap/creditpolicy.

AP Environmental Science

INTRODUCTION

The AP Environmental Science course is designed to be the equivalent of a one-semester, introductory college course in environmental science. Unlike most other introductory-level college 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 Exam 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 exam 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 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.
   - A suitable combination of conservation and development is required.
   - Management of common resources is essential.

Prerequisites

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.

Textbooks

A number of recently published textbooks are appropriate for college students enrolled in introductory courses in environmental science. Reviews of many such textbooks can be found by clicking on the Teachers' Resources tab on the AP Central home page (apcentral.collegeboard.com). The AP Environmental Science teacher should examine a variety of textbooks and use one that will adequately cover the suggested syllabus in a manner and style satisfactory to the teacher and the students. Among the major considerations to be used in choosing a text are depth and breadth of coverage, quality of illustrations, readability, clarity of presentation, value of end-of-chapter questions, availability of other teaching aids, and the capacity to stimulate student interest. A recently published textbook should be chosen so as to ensure that the information it contains is current and accurate.

School systems should recognize that the rapidly changing nature of environmental science requires regular updating of textbooks. While textbooks serve as valuable references, they cannot be exhaustive. Professional development—especially remaining current with new discoveries, events, and conceptual trends—is one responsibility of any AP teacher.

Topic Outline

The following outline of major topics serves to describe the scope of the AP Environmental Science course and 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. The percentage after each major topic heading shows the approximate proportion of multiple-choice questions on the exam that pertain to that heading; thus, the percentage also indicates the relative emphasis that should be placed on the topics in the course.

I. Earth Systems and Resources (10–15%)

A. Earth Science Concepts
(Geologic time scale; plate tectonics, earthquakes, volcanism; seasons; solar intensity and latitude)

B. The Atmosphere
(Composition; structure; weather and climate; atmospheric circulation and the Coriolis Effect; atmosphere–ocean interactions; ENSO)

C. Global Water Resources and Use
(Freshwater/saltwater; ocean circulation; agricultural, industrial, and domestic use; surface and groundwater issues; global problems; conservation)

D. Soil and Soil Dynamics
(Rock cycle; formation; composition; physical and chemical properties; main soil types; erosion and other soil problems; soil conservation)

II. The Living World (10–15%)

A. Ecosystem Structure
(Biological populations and communities; ecological niches; interactions among species; keystone species; species diversity and edge effects; major terrestrial and aquatic biomes)

B. Energy Flow
(Photosynthesis and cellular respiration; food webs and trophic levels; ecological pyramids)

C. Ecosystem Diversity
(Biodiversity; natural selection; evolution; ecosystem services)

D. Natural Ecosystem Change
(Climate shifts; species movement; ecological succession)

E. Natural Biogeochemical Cycles
(Carbon, nitrogen, phosphorus, sulfur, water, conservation of matter)

III. Population (10–15%)

A. Population Biology Concepts
(Population ecology; carrying capacity; reproductive strategies; survivorship)

B. Human Population

1. Human population dynamics
(Historical population sizes; distribution; fertility rates; growth rates and doubling times; demographic transition; age-structure diagrams)

2. Population size
(Strategies for sustainability; case studies; national policies)

3. Impacts of population growth
(Hunger; disease; economic effects; resource use; habitat destruction)

IV. Land and Water Use (10–15%)

A. Agriculture

1. Feeding a growing population
(Human nutritional requirements; types of agriculture; Green Revolution; genetic engineering and crop production; deforestation; irrigation; sustainable agriculture)

2. Controlling pests
(Types of pesticides; costs and benefits of pesticide use; integrated pest management; relevant laws)

B. Forestry
(Tree plantations; old growth forests; forest fires; forest management; national forests)

C. Rangelands
(Overgrazing; deforestation; desertification; rangeland management; federal rangelands)

D. Other Land Use

1. Urban land development
(Planned development; suburban sprawl; urbanization)

2. Transportation infrastructure
(Federal highway system; canals and channels; roadless areas; ecosystem impacts)

3. Public and federal lands
(Management; wilderness areas; national parks; wildlife refuges; forests; wetlands)

4. Land conservation options
(Preservation; remediation; mitigation; restoration)

5. Sustainable land-use strategies

E. Mining
(Mineral formation; extraction; global reserves; relevant laws and treaties)

F. Fishing
(Fishing techniques; overfishing; aquaculture; relevant laws and treaties)

G. Global Economics
(Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

V. Energy Resources and Consumption (10–15%)

A. Energy Concepts
(Energy forms; power; units; conversions; Laws of Thermodynamics)

B. Energy Consumption
1. History
(Industrial Revolution; exponential growth; energy crisis)
2. Present global energy use
3. Future energy needs

C. Fossil Fuel Resources and Use
(Formation of coal, oil, and natural gas; extraction/purification methods; world reserves and global demand; synfuels; environmental advantages/disadvantages of sources)

D. Nuclear Energy
(Nuclear fission process; nuclear fuel; electricity production; nuclear reactor types; environmental advantages/disadvantages; safety issues; radiation and human health; radioactive wastes; nuclear fusion)

E. Hydroelectric Power
(Dams; flood control; salmon; silting; other impacts)

F. Energy Conservation
(Energy efficiency; CAFE standards; hybrid electric vehicles; mass transit)

G. Renewable Energy
(Solar energy; solar electricity; hydrogen fuel cells; biomass; wind energy; small-scale hydroelectric; ocean waves and tidal energy; geothermal; environmental advantages/disadvantages)

VI. Pollution (25–30%)

A. Pollution Types
1. Air pollution
(Sources—primary and secondary; major air pollutants; measurement units; smog; acid deposition—causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)
2. Noise pollution
(Sources; effects; control measures)
3. Water pollution
(Types; sources, causes, and effects; cultural eutrophication; groundwater pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)

4. Solid waste
   (Types; disposal; reduction)

B. Impacts on the Environment and Human Health
   1. Hazards to human health
      (Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)
   2. Hazardous chemicals in the environment
      (Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)

C. Economic Impacts
   (Cost-benefit analysis; externalities; marginal costs; sustainability)

VII. Global Change (10–15%)

A. Stratospheric Ozone
   (Formation of stratospheric ozone; ultraviolet radiation; causes of ozone depletion; effects of ozone depletion; strategies for reducing ozone depletion; relevant laws and treaties)

B. Global Warming
   (Greenhouse gases and the greenhouse effect; impacts and consequences of global warming; reducing climate change; relevant laws and treaties)

C. Loss of Biodiversity
   1. Habitat loss; overuse; pollution; introduced species; endangered and extinct species
   2. Maintenance through conservation
   3. Relevant laws and treaties

LABORATORY AND FIELD INVESTIGATION

Because it is designed to be a course in environmental *science* rather than 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. **Colleges often require students to present their laboratory materials from AP science courses before granting college credit for laboratory, so students should be encouraged to retain their laboratory notebooks, reports, and other materials.**

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, activities should:

- always be linked to a major concept in science and to one or more areas of the course outline
- allow students to have direct experience with an organism or system in the environment
- 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

It is expected that students will perform as many labs/field investigations as possible; these investigations should fulfill the criteria outlined above. There are no specific AP Environmental Science classroom labs or field investigations required for the course; thus, teachers have greater flexibility when it comes to the types of labs, field investigations, and field trips that are undertaken in their courses. Depending on location, students could perform water tests on a freshwater pond, a river, or an estuary/marine environment. Every teacher should provide students with opportunities to perform experiments and analyses involving the study of air, water, and soil qualities as an essential core for the lab/field investigation activities.

The *AP Environmental Science Teacher's Guide* provides many resources for lab/field investigation activities from both college and high school AP teachers. This publication is available in the College Board Store at AP Central (store.collegeboard.com). AP Central and the Environmental Literacy Council (enviroliteracy.org) also have a collection of inquiry-based environmental science labs and field investigations that have been produced by a group of college and high school teachers and that are suitable for an AP Environmental Science course. In addition, ideas for labs and other activities can be exchanged on the moderated AP Environmental Science Electronic Discussion Group (EDG) for teachers on AP Central.

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 to teach the entire course. In these situations, teachers should seek the expertise of their colleagues, by either team teaching, using guest lecturers, or having 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 to an AP Environmental Science course. School administrators should provide the equivalent of two double periods per 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 EXAM

The AP Environmental Science Exam is 3 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 6–9).

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: 1 data-set question, 1 document-based question, and 2 synthesis and evaluation questions. Questions from the 2006 exam appear on pages 17–20.

To provide maximum information about differences in students' achievements in environmental science, the exam 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 the AP Exam more difficult than most classroom exams. 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 exam.

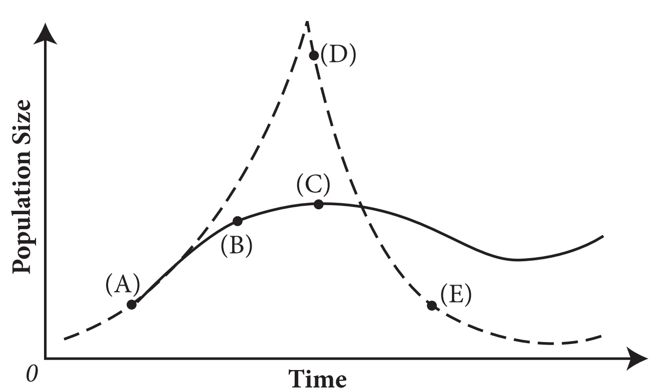
Sample Multiple-Choice Questions

The following are examples of the kinds of multiple-choice questions found on the AP Environmental Science Exam. Students should spend an average time of less than 1 minute on each multiple-choice question, since 90 minutes are allotted for answering 100 questions.

Multiple-choice scores are based on the number of questions answered correctly. Points are not deducted for incorrect answers, and no points are awarded for unanswered questions. Because points are not deducted for incorrect answers, students are encouraged to answer all multiple-choice questions. On any questions students do not know the answer to, students should eliminate as many choices as they can, and then select the best answer among the remaining choices. An answer key to the multiple-choice questions can be found on page 16.

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?

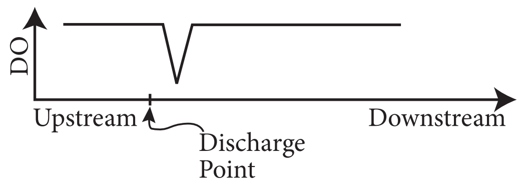
   (A) Loss of fertile delta regions for agriculture
   (B) Change in global patterns of precipitation
   (C) Extinction of some species that have narrow temperature requirements
   (D) Decreased rate of photosynthesis in vegetation
   (E) Increased frequency of hurricanes

5. When X joules of nuclear energy is used to produce Y joules of electrical energy, which of the following is true?

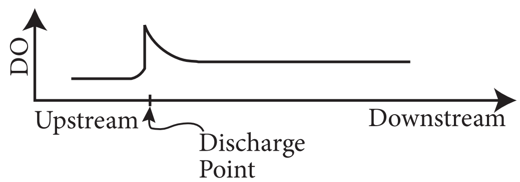
   (A) In every case, $X > Y$
   (B) In every case, $X = Y$
   (C) In every case, $X < Y$
   (D) Either $X < Y$ or $X > Y$, depending on the efficiency of the generator
   (E) Either $X < Y$ or $X > Y$, depending on the amount of heat produced

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?

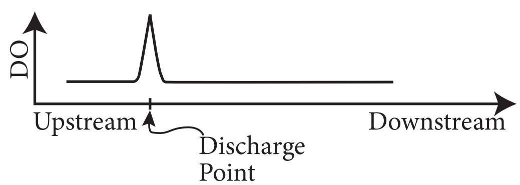
(A)



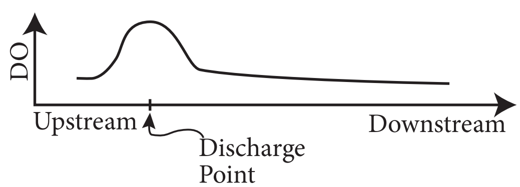
(B)



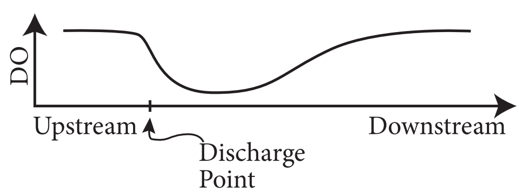
(C)



(D)



(E)



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 PCBs.

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 exam consists of 4 required questions: 1 data-set question, 1 document-based question, and 2 synthesis and evaluation questions. The following questions appeared on the 2006 exam. Additional sample questions can be found at AP Central.

1. Upon receiving notice from their electric utility that customers with solar power systems are permitted to sell excess power back to the utility, an Arizona family is considering the purchase of a photovoltaic solar energy system for their 2,700-square-foot suburban home. The initial costs of the systems they are considering range from $7,000 to $30,000. While gathering information prior to making a decision, the homeowners find the following information at the Web site of the United States Department of Energy.

Stand-Alone vs. Grid-Connected Systems

Stand-alone systems produce power independently of the utility grid. In some off-the-grid locations as near as one-quarter mile from the power lines, stand-alone photovoltaic systems can be more cost-effective than extending power lines. Direct-coupled systems need no electrical storage because they operate only during daylight hours, but most systems rely on battery storage so that energy produced during the day can be used at night. Some systems, called hybrid systems, combine solar power with additional power sources such as wind or diesel.

Grid-connected photovoltaic systems supply surplus power back through the grid to the utility and take from the utility grid when the home system's power supply is low. These systems remove the need for battery storage, although arranging for the grid interconnection can be difficult. In some cases, utilities allow net metering, which allows the owner to sell excess power back to the utility.

(a) Describe one environmental benefit and one environmental cost of photovoltaic systems.

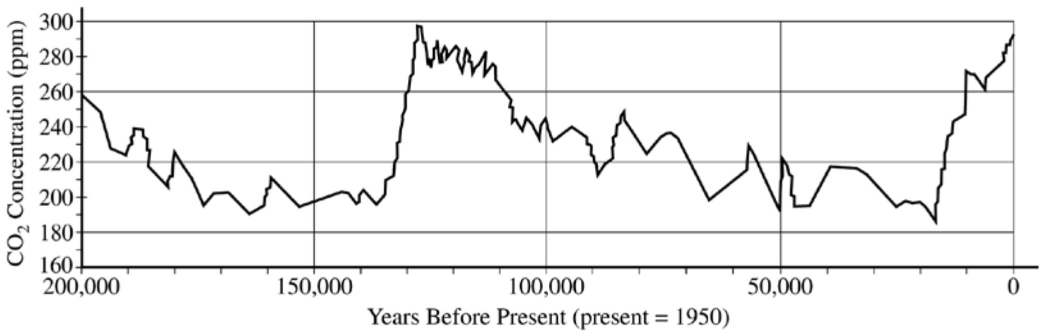
(b) From the two types of solar systems described on the government Web site, select the system (either stand-alone or grid-connected) that you think best meets the needs of the homeowners. Write an argument to persuade them to purchase the system you selected. Include the pros and cons of each system in your argument.

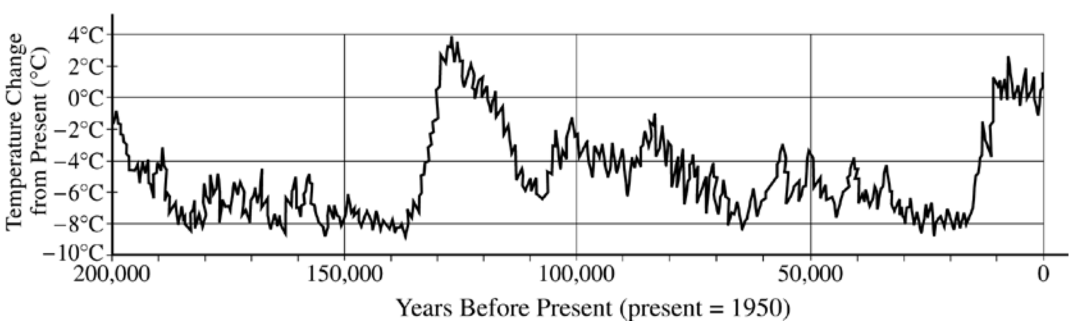
(c) Describe TWO ways that government or industry could promote the use of photovoltaic power systems for homeowners in the future.

(d) Describe TWO ways that homeowners could use passive solar designs and/or systems and, for each way, explain how it would reduce the homeowners' energy costs.

2. According to atmospheric temperature and CO_2 concentration records derived from Antarctic ice cores, Earth's climate has undergone significant changes over the past 200,000 years. Two graphs are shown below. The upper graph shows the variation in atmospheric CO_2 concentration, and the lower graph shows the variation in air temperature. Both graphs cover the same time period from approximately 200,000 years ago up until the year 1950, which is represented as year 0 on the graphs.

TEMPERATURE AND CO_2 CONCENTRATION IN THE ATMOSPHERE OVER THE PAST 200,000 YEARS





(a) Answer the following questions that relate to the graphs above. Remember that for any calculations you must clearly indicate how you arrived at your answer. Answers must also include appropriate units.

(i) Determine the net change in atmospheric CO_2 concentration between 140,000 years ago and 125,000 years ago.

(ii) Calculate the ratio of the change in mean global temperature to the change in atmospheric CO_2 concentration between 140,000 years ago and 125,000 years ago.

(iii) Scientists predict that between 1950 and 2050, the atmospheric CO_2 concentration will increase by 200 ppm. Predict the change in mean global temperature between 1950 and 2050 using the ratio that you calculated in part (ii).

(iv) Describe one major assumption that was necessary to make the prediction in part (iii) above. Discuss the validity of the assumption.

(b) Identify and describe TWO major causes for the predicted 200 ppm increase in atmospheric CO_2 concentration between 1950 and 2050.

(c) Identify TWO gases other than CO_2 that contribute to the anthropogenic increase in mean global temperature. For each gas, describe a major human activity that leads to its release.

3. The city of Fremont has a large brownfield located along the Fremont River. The brownfield is a former industrial site where contamination by hazardous chemicals impedes redevelopment. The city council is considering two options for reclaiming the brownfield. The first option is to excavate and remove the contaminated soil, and the second option is to decontaminate the soil on the site using vegetation.

(a) Assume that the city council chooses the first option. Describe TWO problems that result from removing the contaminated soil from the brownfield.

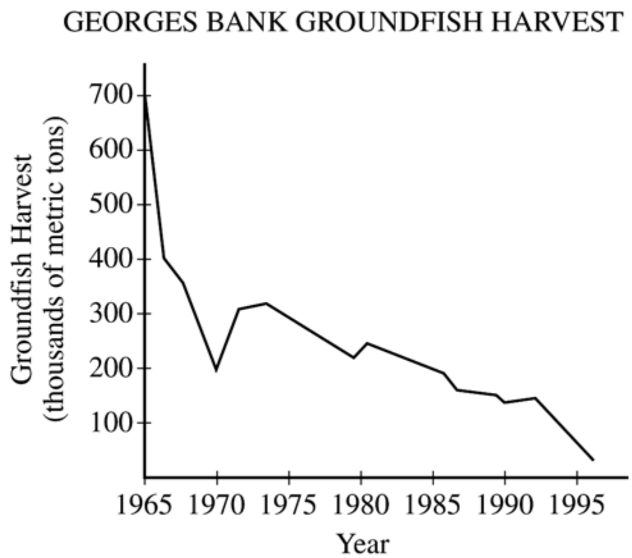
(b) Assume that the city council chooses the second option. Explain how vegetation could be used to decontaminate the soil. Discuss one advantage and one disadvantage of using this reclamation method.

(c) Describe and explain one environmental benefit and one societal benefit of brownfield reclamation.

(d) Identify and describe

(i) one method currently used to reduce the production of hazardous waste and

(ii) one method of legally disposing of hazardous waste.



4. The graph above shows the decline in the catch of groundfish (such as cod, haddock, and flounder) from Georges Bank from 1965 to 1995. This decline in the fish harvest resulted in the closure of large portions of the fishery.

(a) Identify the five-year period during which the greatest rate of decline in the fish harvest took place. For that five-year period, calculate the rate of decline in the fish harvest, in metric tons per year. Show clearly how you determined your answer.

(b) Choose any TWO commercial fishing practices from the list below. For each of your choices, describe the practice and explain the role it plays in the depletion of marine organisms.

- Bottom trawling
- Long-line fishing
- Using drift nets/gill nets/purse seines
- Using sonar

(c) Identify one international regulation or United States federal law that applies to the harvesting of marine food resources and explain how that regulation or law helps to manage marine species.

(d) The oceans of the world are often referred to as a commons. Give an example of one other such commons, explain how human activities affect that commons, and suggest one practical method for managing that commons.

Teacher Support

AP Central® (apcentral.collegeboard.com)

You can find the following Web resources at AP Central:

- AP Course Descriptions, AP Exam questions and scoring guidelines, sample syllabi, and feature articles.
- A searchable Institutes and Workshops database, providing information about professional development events.
- The Course Home Pages (apcentral.collegeboard.com/coursehomepages), which contain articles, teaching tips, activities, lab ideas, and other course-specific content contributed by colleagues in the AP community.
- Moderated electronic discussion groups (EDGs) for each AP course, provided to facilitate the exchange of ideas and practices.

AP Publications and Other Resources

Free AP resources 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. Visit www.collegeboard.com/apfreepubs.

Teacher's Guides and Course Descriptions may be downloaded free of charge from AP Central; printed copies may be purchased through the College Board Store (store .collegeboard.com). Released Exams and other priced AP resources are available at the College Board Store.

Teacher's Guides

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 suggested teaching resources.

Course Descriptions

Course Descriptions are available for each AP subject. They provide an outline of each AP course's content, explain the kinds of skills students are expected to demonstrate in the corresponding introductory college-level course, and describe the AP Exam. Sample multiple-choice questions with an answer key and sample free-response questions are included. (The Course Description for AP Computer Science is available in PDF format only.)

Released Exams

Periodically 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.

Contact Us

National Office
Advanced Placement Program
45 Columbus Avenue
New York, NY 10023-6992
212 713-8066
E-mail: ap@collegeboard.org

AP Services
P.O. Box 6671
Princeton, NJ 08541-6671
609 771-7300
877 274-6474 (toll free in the U.S. and Canada)
E-mail: apexams@info.collegeboard.org

AP Canada Office
2950 Douglas Street, Suite 550
Victoria, BC, Canada V8T 4N4
250 472-8561
800 667-4548 (toll free in Canada only)
E-mail: gewonus@ap.ca

International Services
Serving all countries outside the U.S. and Canada

45 Columbus Avenue
New York, NY 10023-6992
212 373-8738
E-mail: international@collegeboard.org

Middle States Regional Office
Serving Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, Puerto Rico, and the U.S. Virgin Islands

Two Bala Plaza, Suite 900
Bala Cynwyd, PA 19004-1501
866 392-3019
E-mail: msro@collegeboard.org

Midwestern Regional Office
Serving Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, West Virginia, and Wisconsin

6111 North River Road, Suite 550
Rosemont, IL 60018-5158
866 392-4086
E-mail: mro@collegeboard.org

New England Regional Office
Serving Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont

470 Totten Pond Road
Waltham, MA 02451-1982
866 392-4089
E-mail: nero@collegeboard.org

Southern Regional Office
Serving Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia

3700 Crestwood Parkway NW, Suite 700
Duluth, GA 30096-7155
866 392-4088
E-mail: sro@collegeboard.org

Southwestern Regional Office
Serving Arkansas, New Mexico, Oklahoma, and Texas

4330 Gaines Ranch Loop, Suite 200
Austin, TX 78735-6735
866 392-3017
E-mail: swro@collegeboard.org

Western Regional Office
Serving Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming

2099 Gateway Place, Suite 550
San Jose, CA 95110-1051
866 392-4078
E-mail: wro@collegeboard.org

2008-09 Development Committee and Chief Reader

Alan McIntosh, University of Vermont, Burlington, *Chair*
Dolores Eggers, University of North Carolina, Asheville
Claire Kull, Career Center, Winston-Salem, North Carolina
Chinh Nguyen, Lick-Wilmerding High School, San Francisco, California
Duke Ophori, Montclair State University, New Jersey
Jim Serach, Lawrenceville School, New Jersey

Chief Reader: **Art Samel,** Bowling Green State University, Ohio
ETS Consultants: **Tom Corley, Irene Kijak, Beth Nichols**

apcentral.collegeboard.com

I.N. 100083477