

Canals and Channels .....	91
Public and Federal Lands .....	91
Management .....	91
Wetlands .....	92
Land Conservation Options .....	92
Sustainable Land-Use Strategies .....	93
Mining .....	93
Mineral Formation .....	94
Mineral Extraction .....	94
Mining Oceans .....	95
Mining Reclamation .....	95
Mining Laws and Treaties .....	95
Fishing .....	96
Fishing Techniques .....	96
Overfishing .....	96
Coral reefs .....	96
Aquaculture .....	97
Fishing Management .....	97
Global Economies .....	98
Globalization .....	98
World Bank .....	99
Tragedy of the Commons .....	99
Global Economics Laws and Treaties .....	99
Practice .....	100
Answers .....	102
<b>Chapter 5: Energy Resources and Consumption .....</b>	<b>103</b>
Energy Concepts .....	103
APES Math Problems .....	106
Laws of Thermodynamics .....	109
Energy Consumption .....	110
The History of Energy Consumption .....	110
Present Global Energy Use .....	112
Future Energy Use .....	112
Fossil Fuel Resources and Use .....	113
Coal, Oil, and Natural Gas .....	113
World Reserves and Global Demand .....	117
Environmental Advantages and Disadvantages of Fossil Fuels .....	117
Nuclear Energy .....	119
Nuclear Power .....	119
Nuclear Fission Process .....	120
Nuclear Fuel .....	120
Nuclear Reactors .....	121
Nuclear reactor types .....	122
Safety Issues .....	123
Radiation and Human Health .....	123
Understanding Half-Life .....	124
Hydroelectric Power .....	125
Case Study: The Colorado River .....	126
Case Study: Salmon .....	127
Energy Conservation .....	127
Energy Efficiency .....	128
Energy Star .....	128
Corporate Average Fuel Economy .....	129
Hybrid Electric Vehicles .....	130
Mass Transit .....	132

Renewable Energy . . . . .	133
Solar . . . . .	133
Hydrogen Fuel Cells . . . . .	135
Biomass . . . . .	136
Wind . . . . .	137
Geothermal . . . . .	137
Ocean and Tidal Waves . . . . .	138
Practice . . . . .	140
Answers . . . . .	142
<b>Chapter 6: Pollution . . . . .</b>	<b>145</b>
Pollution Types . . . . .	145
Air Pollution . . . . .	145
Noise Pollution . . . . .	151
Light Pollution . . . . .	151
Genetic Pollution . . . . .	152
Water Pollution . . . . .	152
Solid Waste . . . . .	154
Impacts on the Environment and Human Health . . . . .	156
Hazards to Human Health . . . . .	156
Acute and Chronic Effects . . . . .	157
Hazardous Chemicals in the Environment . . . . .	161
Economic Impacts . . . . .	162
Cost-Benefit Analysis . . . . .	162
Marginal Costs . . . . .	163
Cost of Pollution Control . . . . .	164
Sustainability . . . . .	164
Practice . . . . .	165
Answers . . . . .	168
<b>Chapter 7: Global Change . . . . .</b>	<b>169</b>
Stratospheric Ozone . . . . .	169
Formation of Stratospheric Ozone . . . . .	169
Ultraviolet (UV) Radiation . . . . .	170
Ozone Depletion . . . . .	171
Relevant Laws and Treaties . . . . .	175
Global Warming and Climate Change . . . . .	176
Impacts and Consequences of Global Warming . . . . .	179
Reducing Climate Change . . . . .	182
Laws and Treaties . . . . .	182
Loss of Biodiversity . . . . .	183
Massive Extinctions from Human Activity . . . . .	183
Issues Related to Loss of Biodiversity . . . . .	183
Maintenance through Conservation . . . . .	186
Practice . . . . .	188
Answers . . . . .	190

## PART II: PRACTICE EXAMS

<b>Chapter 8: Practice Exam 1 . . . . .</b>	<b>193</b>
Answer Sheet . . . . .	193
Section I . . . . .	193
Section II . . . . .	194
Section I: Multiple-Choice Questions . . . . .	199
Section II: Free-Response Questions . . . . .	213

Answer Key .....	215
Section I: Multiple-Choice Questions .....	215
Answer Explanations .....	216
Section I: Multiple-Choice Questions .....	216
Section II: Free-Response Explanations .....	224
<b>Chapter 9: Practice Exam 2 .....</b>	<b>229</b>
Answer Sheet .....	229
Section I .....	229
Section II .....	230
Section I: Multiple-Choice Questions .....	235
Section II: Free-Response Questions .....	247
Answer Key .....	249
Section I: Multiple-Choice Questions .....	249
Answer Explanations .....	250
Section I: Multiple-Choice Questions .....	250
Section II: Free-Response Explanations .....	256
<b>Chapter 10: Practice Exam 3 .....</b>	<b>261</b>
<b>Answer Sheet</b>	
Section I .....	261
Section II .....	262
Section I: Multiple-Choice Questions .....	267
Section II: Free-Response Questions .....	281
Answer Key .....	283
Section I: Multiple-Choice Questions .....	283
Answer Explanations .....	284
Section I: Multiple-Choice Questions .....	284
Section II: Free-Response Questions .....	290
<b>PART III: RESOURCES</b>	
<b>Appendix A: Glossary .....</b>	<b>297</b>
<b>Appendix B: Case Studies .....</b>	<b>315</b>
Species .....	315
Loss of Amphibians .....	315
Zebra Mussels: Invasive Species .....	315
Extinction of the Passenger Pigeon .....	316
DDT .....	316
Kudzu Invasion .....	316
Reintroduction of Gray Wolves to Yellowstone National Park .....	317
California Condor .....	317
Water .....	318
Lake Erie Waste Dumping .....	318
St. James Bay Hydroelectric Dams .....	318
Gulf of Mexico's Dead Zone .....	318
Aral Sea .....	319
Three Gorges Dam .....	319
California Water Project .....	320
Human .....	320
China: One-Child Policy .....	320
Easter Island: Tragedy of the Commons .....	321
Biosphere 2 .....	321

Events .....	322
Bhopal Chemical Disaster .....	322
Chernobyl Nuclear Disaster .....	322
Cuyahoga River Fire .....	322
Deepwater Horizon Oil Spill .....	322
Exxon Valdez Oil Spill .....	323
Fukushimi Daiichi Nuclear Disaster .....	323
Hurricane Katrina .....	323
Kissimmee River Dredging .....	324
London Fog Air Pollution .....	324
Love Canal Waste Dumping .....	324
Santa Barbara Oil Spill .....	325
Three-Mile Island Nuclear Disaster .....	325
<b>Appendix C: Labs .....</b>	<b>327</b>
Common Labs .....	327
Acid Deposition .....	327
Air Quality .....	327
Biodiesel from Vegetable Oil .....	327
Biodiversity of Invertebrates (Shannon-Wiener Diversity Index) .....	328
Composting with Worms .....	328
Coriolis Effect .....	328
Eco-Columns .....	329
Ecological Footprint .....	330
Ecosystem Ecology .....	331
Energy Audits .....	331
Field Studies .....	331
Food Webs .....	331
Mining .....	331
LD <sub>50</sub> Bioassay .....	331
Oil Spill Cleanup .....	331
Predator-Prey Simulation .....	332
Productivity .....	332
Population Growth in <i>Lemna minor</i> .....	332
Porosity .....	332
Salinization .....	332
Soil Analysis Labs .....	332
Solar Cooker/Solar House .....	334
Specific Heat: Solar Absorption .....	334
Tragedy of the Commons .....	334
Transects .....	334
Water Quality .....	334
Weathering .....	335
Analysis of Past Exams .....	336
Free-Response Questions .....	336
Experimental-Design Questions .....	336
<b>Appendix D: Laws and Treaties .....</b>	<b>337</b>
United States Federal Laws .....	337
International Treaties .....	340

# Study Guide Checklist

---

- 1. Read AP Environmental Science information available on the College Board website ([www.collegeboard.com](http://www.collegeboard.com)).
- 2. Read the Introduction and familiarize yourself with the test format and questions types. Make sure that you understand the different types of multiple-choice questions.
- 3. Review the scoring scales on page 1 for multiple-choice and free-response questions.
- 4. Read the chapters of this book to refresh your understanding of the material covered.
- 5. Practice multiple-choice questions at the end of each chapter, and review the answers and explanations to determine areas in which you need improvement.
- 6. Review the appendices.
- 7. Take each Practice Test, strictly observing the time allotments.
- 8. Review the answer explanations for each test. Analyze your strengths and weaknesses after each test. Before you proceed to the next Practice Test, go back over any information you missed by rereading specific chapter material as necessary.

# Introduction

The study of environmental science is increasing in popularity and global relevance. The Advanced Placement Environmental Science examination focuses on your ability to identify and analyze environmental issues and scientific concepts within the natural world. The exam requires you to recall and utilize basic facts and concepts to answer and critically evaluate problems related to physical geography, ecosystems, cultural geography, land and water use, energy, pollution, and global change. These can be natural and/or human-made problems. The risks connected to these problems also are studied.

The AP Environmental Science exam is offered by the nonprofit College Board and administered by the Educational Testing Service (ETS) to those students interested in testing in environmental and natural sciences. The exam is recognized by over 3,800 colleges and universities (approximately 90 percent). Students who score successfully on the exam may qualify to receive college credit for a comparable college-level course.

## Format and Scoring

The following table outlines the format of the AP Environmental Science exam.

Section	Number of Questions	Time
Section I: Multiple choice	100 questions	90 minutes
Section II: Free response	4 essays	90 minutes

In the multiple-choice section, you earn one point for each correct answer. In 2011, a quarter-point deduction from the total for each wrong answer was discontinued. Because there is no longer a penalty, it is in your best interest to take an educated guess. Unanswered questions do not count for or against your score. The multiple-choice section is 60 percent of your total exam score.

In the free-response essay section, each of the four essays is scored holistically, and scores range from zero to ten (or zero for a blank paper). These scores are then calculated to equal 40 percent of the total exam score. The essays may have different point values depending upon their complexity, but all essays carry the same weight value. This means that each will count for one-quarter of your score in the free-response section of the test.

The free-response questions are scored by college professors and highly qualified high school AP teachers using standards developed by a committee of the College Board. Students are notified by mail of their test results. In addition, students, teachers, and administrators can see the scores online at the College Board website ([www.collegeboard.com](http://www.collegeboard.com)). Each year the free-response questions, scoring guides, student samples, and other information are posted online.

The multiple-choice section score is added to the free-response section score to produce a composite total score. This composite is translated into a five-point scale that is reported to the student, the student's high school, and any college designated by the student.

The College Board scores the exam on a five-point scale:

- 5 = Extremely well qualified
- 4 = Well qualified
- 3 = Qualified
- 2 = Possibly qualified
- 1 = No recommendation



A score of 3 is considered passing, but most colleges and universities require a score of 4 or 5 to receive credit or placement. A score of 1 or 2 is not accepted for credit. On previous exams, the mean score was approximately 2.6 and 50 percent of the students scored 3 or higher. Colleges and universities establish their own policies regarding what scores qualify. Updated scoring information is available through the College Board at <http://collegesearch.collegeboard.com/search/index.jsp>. Enter the name of the university in the College QuickFinder section and go to the Tests section when you get to the profile. Here you can see what scores are acceptable for placement, credit, or both. Because colleges and universities frequently change their policies and regulations, it is always a good idea to double-check with colleges directly when in doubt about acceptable credits.

## Underlying Themes and Topics

### Themes

The study of environmental science incorporates many aspects of both physical and biological sciences and focuses on how humans and the environment are intertwined and impact one another. In the AP Environmental Science course, the basic principles of science underscore the material.

Earth is a system with many interconnected components, both living and nonliving. Because humans are part of this system, people can alter and impact the Earth's cycles and processes. Both population growth and technological advancements have increased the rate at which humans have modified the natural environment. The implications of human actions not only have a physical effect but also impact social, economic, and political structures. The management and responsible use of the Earth's resources is, therefore, essential to the continued success of humans and the planet.

### Topics

The College Board Development Committee has established seven major topics that provide the content standards for the AP Environmental Science exam. Each topic is further divided to provide the basics to understanding the course material.

Topics on the AP Environmental Science Exam		
Topic	Description	Portion of Exam
Earth Systems and Resources	Includes key geologic processes such as plate tectonics, the rock cycle, and soil formation. Also includes seasons, atmospheric properties, weather and climate, solar radiation, the relationship between the atmosphere and oceans, freshwater, and saltwater.	10% to 15%
The Living World	Involves ecosystem interactions and structure in both aquatic and terrestrial biomes, including components of populations and communities, flow of energy and nutrients, natural selection and evolution, and changes in ecosystems.	10% to 15%
Population	Focuses on components of a population including reproductive strategies, interactions, characteristics, growth, transition, and carrying capacity. The human population is also addressed and includes implications of population growth and sustainable practices.	10% to 15%
Land and Water Use	Addresses human use of land and water resources, including agriculture, forestry, development, fishing, and mineral resource use. Conservation and preservation are also included.	10% to 15%

Topic	Description	Portion of Exam
Energy Resources and Consumption	Involves assessments of nonrenewable fossil fuels as energy sources and alternative and renewable sources, such as nuclear, hydropower, solar, wind, biomass, hydrogen, tidal, and geothermal sources. Human use and approaches to efficiency are also addressed.	10% to 15%
Pollution	Addresses types of pollution, including air, soil, water, and noise pollution, as well as the impacts on humans physically and economically.	25% to 30%
Global Change	Includes issues relating to the earth as a whole, such as atmospheric change, climate alteration, and biodiversity loss.	10% to 15%

## Multiple-Choice Questions

The multiple-choice questions cover a broad range of topics while considering a variety of themes and scientific constructs. To be successful on the exam, you need to have a solid depth and breadth of knowledge about these important areas of study in environmental science. This section provides you with valuable information detailing the underlying themes and topics relevant to the basics of the AP Environmental Science exam. The information provided will also help you to identify and analyze areas that are foundational to your success on the exam.

We recommend that you budget your time wisely to be sure that you have enough time to finish all sections. Because you have 90 minutes to complete the multiple-choice section, you should spend less than 1 minute per question to answer 100 questions. Multiple-choice scores are based on the number of questions answered correctly and no points are deducted for incorrect answers. Eliminate as many incorrect answer choices as possible and make an educated guess from the remaining answer choices. Multiple-choice questions are scored by computer soon after the exam in mid-May.

## Question Types

Multiple-choice questions are designed to test your knowledge and understanding of environmental science. Questions cover the topics noted in the preceding section and require you to recall basic facts and major concepts. They may appear as different question types:

- Matching
- Problem solving
- Multiple-multiple choice
- Cause and effect
- Tables, graphs, and charts
- Basic math

We cover each of these question types in the following sections.

### Matching

Matching problems require you to match a word with a statement. Match the correct word from the five-lettered choices A through E to the statements. Note that, in the following examples, choices A through E may be used more than once or not at all.



## EXAMPLES:

- A. Coal
- B. Sun
- C. Aluminum
- D. Trees
- E. Clay

1. A resource that is a fossil fuel.

The correct answer is A. Coal is the only fossil fuel listed. It is one of three types of fossil fuels; the others are natural gas and crude oil. Fossil fuels come from organic material that has undergone a chemical change due to pressure and heat. Fossil fuels take millions of years to form.

2. A resource that is a metallic mineral.

The correct answer is C. Aluminum is a metallic ore. Aluminum ore is mined and processed to obtain the aluminum for human use.

3. A resource used in the storage of foods and drinks.

The correct answer is C. Aluminum is used to store drinks for a long shelf life such as soda, noncarbonated drinks (such as fruit juice), teas, and other drinks. Aluminum also is rolled into thin sheets to produce aluminum foil, which is used to wrap foods for cooking and storing.

**Remember:** In matching problems, the same answer may be used more than once. Therefore, choice C is the correct answer for both questions 2 and 3.

4. A resource that is considered renewable and is a primary source of energy in many parts of the world.

The correct answer is D. Trees are considered a renewable resource and can be replanted to grow within a normal human life span. Trees also are biomass, which is a major form of energy in many developing countries.

## Problem Solving

Problem-solving questions are framed as standard questions, reverse-type questions identified with the words *except* or *not*, or short quotations followed by five possible answer choices. Many problem-solving questions are straightforward and require you to remember facts and significant developments in environmental science. The goal is to determine the best possible answer to the question.

## EXAMPLE:

During the last 50 years, meat consumption worldwide has nearly doubled. Which is NOT a disadvantage of an associated increase in meat production?

- A. Increase of greenhouse gases due to increased use of fossil fuel in meat production
- B. Concentration of animal waste in a small area
- C. Increased use of antibiotics, which has led to an increased resistance to microbes
- D. Increased protein in the diet of humans
- E. Increased inputs of grain, water, and fossil fuels

The correct answer is D. The increased consumption of protein is considered part of the reason why the average human height has increased. The other four answer choices are all disadvantages to the current method we use to produce meat for human consumption. Increased meat production, especially cattle, has seen an increase in feed and water for meat production. As more fossil fuels are used, more greenhouse gases are released. The animals are often housed in small pens, which concentrates their waste in a small area. Finally, to help prevent the spread of disease, antibiotics are routinely given to the animals.

## Multiple-Multiple Choice

In multiple-multiple-choice questions, you are given three statements numbered I through III. You must determine which of these three statements is correct and choose the corresponding answer choice. The correct choice may be one of the statements, two of the statements, or all three of the statements.

EXAMPLE:

Which of these is an environmental impact of mining for ore?

- I. Increased air pollution from dust and particles in the air
  - II. Increased availability of fossil fuels
  - III. Increased soil degradation from mining activities
- A. I only
  - B. II only
  - C. III only
  - D. I and II only
  - E. I and III only

The correct answer is E. When ore is mined, there are many possible outcomes. The land is altered and disturbed, causing dust particles to pollute the air. In addition, there can be runoff into water systems, causing increased erosion, a destruction of habitat, and a loss of biodiversity. Coal, iron, and aluminum are a few examples of mined ores.

## Cause and Effect

A cause-and-effect problem describes a relationship between one event (cause) and another event (effect). Because this is a test of your knowledge of environmental science, a common cause-and-effect problem will focus on the effect that an event had upon the environment.

EXAMPLE:

Love Canal is both an environmental disaster and a human health disaster. Which of the following is NOT a consequence of Love Canal?

- A. There has been an increase in birth defects.
- B. A river flowing through the area has spread chemicals beyond Love Canal.
- C. Vegetation has died and, in most places, only small shrubs grow.
- D. There has been an increase in miscarriages.
- E. Metal drums filled with chemicals showed visible signs of deteriorating in some areas of the dumping zone.

The correct answer is B. A river did not flow through the area and spread chemicals downriver. In this example, notice that all the choices except B describe environmental health concerns. Therefore, B is not a consequence of Love Canal.

## Tables, Graphs, and Charts

Some questions on the exam present you with a table, graph, or chart and ask you to answer one or more questions based on it.

EXAMPLE:

Biome Characteristics	
Trait	Description
Precipitation	Moderate precipitation; two prolonged dry seasons with abundant rain the rest of the year
Temperature	Warm year-round
Location	Africa
Fauna	Herds of grazing and browsing hoofed animals, including zebras, giraffes, and antelopes
Flora	Grasses, scattered shrubs, and occasional deciduous trees

The information in the table is characteristic of which of the following biomes?

- A. Temperate grassland
- B. Tropical rain forest
- C. Polar grassland
- D. Savanna
- E. Deciduous forest

The correct answer is D. The biome described is a savanna. Because the table lists the location as Africa, you can eliminate polar grassland (choice C). Animals such as zebras and giraffes are not found in temperate grasslands, eliminating choice A. The flora (plant life) is primarily grass, which indicates that the biome is not a tropical rain forest (choice B) or a deciduous forest (choice E). That leaves the correct answer, choice D.

Notice that by using the process of elimination, you can narrow the choices. This elimination strategy is useful when you are not sure which answer choice is correct but you know which choices are incorrect.

### Basic Math

Basic math questions require simple computation and may require more time to answer than the other question types. Unless math is your strength and you think you can easily answer the problem in less than a minute, mark the question and move on. You can go back and answer the questions you marked at the end. (For more on this strategy, see the next section.)

EXAMPLE:

A nation currently has a population of 200 million and an annual growth rate of 3.5 percent. If the growth rate remains constant, what will be the population of this nation in 40 years?

- A. 250 million
- B. 400 million
- C. 600 million
- D. 800 million
- E. 1 billion

The correct answer is D. This calculation question requires that you apply your knowledge of the Rule of 70, which says that the approximate time it would take a population to double (known as the doubling time, or  $dt$ ) is expressed by the following formula:

$$dt = \frac{70}{\text{growth rate}}$$

Use the Rule of 70 to obtain the doubling time ( $dt$ ):

$$dt = \frac{70}{3.5} = 20 \text{ years}$$

So, the population will double in 20 years. However, the question asks for what the population will be in 40 years, so there are two doubling times. You start with 200 million people. After the first 20 years, the population is  $200 \text{ million} \times 2 = 400 \text{ million}$ . Then, after another 20 years, the population is  $400 \text{ million} \times 2 = 800 \text{ million}$ .

Keep in mind that the dynamics of population growth rates are complex. The Rule of 70 tells you what the doubling time would be if the population were growing exponentially at a constant rate.

## Strategies

Many students who take the AP Environmental Science exam do not get their best possible score on the multiple-choice questions because they spend too much time on difficult questions and fail to leave enough time to answer the easy questions. Do not let this happen to you. Keep in mind that there is no right or wrong way to answer questions, but there are general strategies that can help you get your best possible score.

Because every multiple-choice question is given the same point value, consider the following guidelines when taking the exam:

- **Manage your time wisely.** When you begin the exam, make a note of the starting time in your test booklet (not your answer booklet). Keep in mind that you will have an average of less than a minute for each multiple-choice question (there are 100 questions and you have 90 minutes).
- **Read each question carefully.** Do not make a hasty assumption that you know the correct answer without reading the whole question and all the possible answers.
- **Mark the correct answer on your answer sheet.** Be very careful that your responses on the answer sheet match the question number. When answering questions quickly, it is common to fill in the wrong number on the answer sheet (especially if you have skipped a question), which may throw off all the subsequent questions.
- **Answer all the questions.** To guarantee the highest number of correct answers, you must answer every question in the multiple-choice section.

Use the plus-minus strategy to help you answer questions that are solvable first (those that require minimal thought). Try to work all the way through the entire set of 100 questions, even though you will probably be skipping quite a few questions. Some of the questions at the end of the test might be very easy for you to answer. If you try to answer an early question that takes a long time to reason out, you may not have time to read the questions at the end of the exam. Time saved by using the plus-minus strategy will also allow you more time later to tackle the questions that are more difficult.

## The Plus-Minus Strategy

- Answer the easy questions immediately. If a question is not easy, mark it with either a plus (+) or a minus (-). Mark a plus (+) next to the questions that you think will be easy to answer but are too time-consuming during the first round. Mark a minus (-) next to the questions that seem difficult to answer. Continue this process until you have either answered or marked all 100 questions. Then go back through and answer all the questions you marked with a plus (+). Finally, go back and answer all the questions you marked with a minus (-). If you find that a question is impossible to answer, try to eliminate incorrect answers to increase your odds of guessing the right answer; fill in your answer sheet and move on.
- You will notice that as you are working through the exam, a later question may trigger your memory of how to solve an earlier question that you marked with a minus (-). If this happens, write a quick note to yourself in the test booklet so you can remember how to answer the minus (-) question later. Do not try to hunt for the question when your memory is triggered or you will lose valuable time. You can always go back to the original question later, after you have finished the entire multiple-choice section.
- If you run out of time, and you still have questions unanswered, choose one letter (A, B, C, D, or E) and use it for the remainder of the questions. Statistically, your odds of guessing the correct answer are greater when you choose one letter for all the unanswered questions instead of filling in different letters for different questions.

## Free-Response Questions

There are four essay questions on the AP Environmental Science exam. You will be given 90 minutes for this part of the exam to write all four essays. You will have approximately 22 minutes to write each essay. **Remember:** The score on the free-response questions is 40 percent of your total overall grade.

## What Not to Do

- Do not waste time on background information or a long introduction unless the question calls for historical development or historical significance. Answer the question.
- Do not ramble. Get to the point. Say what you know and go on to the next question.
- Do not worry about spelling every word correctly or using perfect grammar. Incorrect spelling, grammar, and sentence structure are not a part of the criteria for grading standards, but you need to minimize your errors.
- Do not write about multiple topics if given a choice of two or three topics to write about. Only the first one(s) you write about will count. If you decide that your first choice was a bad one, then cross out that part of the answer so the reader clearly knows which part you want to be considered for credit.
- Do not leave questions blank. There is no penalty for a wrong guess.
- Do not list items in an outline form. Always use complete sentences.
- Do not use a calculator. For questions involving calculations, calculators are not allowed. You can receive credit for setting up a problem correctly and showing all work including correct units. You will not receive credit for only providing the correct answer.
- Do not quit!

## Question Types

There are three types of free-response questions on the exam:

- Data analysis
- Document-based
- Synthesis and evaluation

We cover each of these question types in the following sections.

### Data Analysis

In data-analysis questions, information is provided in the form of a map, table, chart, graph, or written, and you will be asked to analyze and interpret the information in your essay. The data provided requires some calculations you must solve before writing your essay. Although the use of calculators is not permitted on the exam, complex calculations are not required.

### Graphing

There are two basic graphs on the free-response section of the AP Environmental Science exam: those that you draw and those that are provided for you. Graphs that you draw also may require an interpretation.

Here are some steps to follow when including a graph on the free-response portion of the exam:

1. **Set up the graph with the independent variable along the  $x$ -axis and the dependent variable along the  $y$ -axis.**
2. **Mark off the axes in equal (proportional) increments and label with proper units of measure.**

You may be provided with grids to help you decide the scale of the graph. However, you may be given only the  $x$ - and  $y$ -axes, so you must demonstrate accuracy in your graphing skills. If the latter is the case, set a desired length and draw small marks on the  $x$ - and  $y$ -axes and lightly trace a grid to achieve accuracy.

3. **Plot the points and attempt to draw in the curve or line.**
4. **If more than one curve or line is plotted, write a label on each curve.**

Labels are better than legends.

5. **Label each axis.**
6. **Give your graph an appropriate title denoting what the graph is showing.**

### Document-Based

Document-based questions require you to read a real-life document (for example, a magazine or newspaper article) and respond to the questions provided based on that information from the document. You should draw on your knowledge of environmental science to respond.



## Synthesis and Evaluation

There are two synthesis and evaluation questions on the exam. These question types may ask you to draw conclusions in relationships between two or more environmental science concepts.

### Experimental Design

In 1999, 2001, and 2003, an experimental design question appeared on the AP Environmental Science exam. Although the type of question may not appear again, it is important to be familiar with this question type in the event that one appears on your exam. In 1999, there was a synthesis and evaluation question. In 2001 and 2003, there were document-based questions.

If you are asked to design or describe an experiment, be sure to include the following:

- A hypothesis and/or predictions
- The independent variable (what treatments you will apply)
- The dependent variable (what you will measure)
- Several variables to be controlled (very important)
- The organism, materials, and apparatus to be used
- What you will do
- How you will take and record data
- How the data will be graphed and analyzed
- How you will draw a conclusion (compare results to hypothesis and predictions)

Your experimental design needs to be at least theoretically possible. It is very important that your conclusions or predictions be consistent with the principles involved and with the way you set up the experiment. When designing the experiment, plan it backward—work from the expected result to the hypothesis. This is a great place to use the note-taking booklet that is returned to ETS. Write it backward (expected result → hypothesis); then write it in the typical experimental-design method (hypothesis → results):

1. **Expected results:** What is your conclusion? Compare it to your hypothesis.
2. **Analysis:** How are you going to analyze the results (graph, calculations, and so on)?
3. **Procedure:** A brief outline of how you are going to conduct the test. This is a great place to discuss your control group and experimental group and dependent and independent variables. Explain what data you will collect and how you will collect the data.
4. **Hypothesis:** This is a testable outcome to the problem. It is a prediction of what you think will happen. You may use the null hypothesis if you expect nothing to happen. If using a null hypothesis, then an alternate hypothesis must be provided as well.

## Strategies

During the administration of the exam, you will be given a separate answer booklet to write your essay responses. After the exam, your answer booklet with your written essays will be sent to ETS to be graded. The question booklet, however, will be returned to you within 48 hours after the exam. During the exam, the question booklet



is a great place to organize your notes, outline your answers and write down calculations. Only essays written in the answer booklet will be graded, so be sure that you transfer any notes you want to be graded to your answer booklet. Each essay will probably be no longer than two pages.

- **Read and mark the questions.** Read all four questions before you attempt to answer them. Before you begin to answer any question, carefully reread the question and restate the question to yourself before attempting to answer it. Circle or underline key words or phrases in the prompt, and be sure that you clearly understand what is being asked. A common mistake is misreading the question. Be sure to answer the question asked and *only* that question, and be sure to respond to *all* parts of the question. As you read the accompanying passage analytically, always keep the essay question in mind.
- **Identify key words and phrases.** Pay close attention to words used in the directions such as: *analyze, assess, calculate, compare, contrast, define, describe, discuss, evaluate, explain, graph, identify, provide evidence for, and support*. Be sure to follow the directions.
- **Start with the question you find the easiest to answer.** Many times while answering one question, you will recall answers to other questions. If this happens, write down this information as a reminder to help you later. If you are given a choice of parts to answer, choose carefully. It is best if you can answer the question parts in the order presented, but you don't have to. It's a great idea to label the parts "A," "B," "C," and so on, as they are labeled in the question. You can always answer the earlier parts later, and you don't need to save space—just label the section.
- **Prewrite.** The purpose of prewriting is to organize your thoughts and plan your essay. Use the space in the test booklet. Twenty-two minutes is not a great deal of time to develop and write a coherent essay, but by writing down your thoughts and ideas, you should be able to clearly organize your written response. It should take only a few minutes to outline your thoughts and ideas in the test booklet. It is important to write an essay that clearly supports scientific facts, concepts, and principles. Thinking and planning ahead helps avoid scratch-outs, asterisks, skipping around, and rambling on your written response.
- **Answer each question.** If you cannot answer all the parts of the question, answer what you can. Try to write a complete response to the question when possible, but you may earn points if your essay fits the scoring rubric specifications.
- **Remember that outlines and diagrams, no matter how elaborate and accurate, are not essays.** Outlines will not earn you much, if any, credit by themselves. Write the essay! There is one exception: If you are asked to calculate a number as a part of an essay, be sure to show how you arrived at your answer. Show the formulas you used and the values inserted into those formulas. Many times, points are awarded for setting up the problem. If you provide only the answer and do not show how you obtained the answer, you will receive no points. In addition, be sure to show all units. If you are asked to include a diagram, be sure to label the components carefully and correctly.
- **Remember that only the answer booklet is turned in for a score.** If the question asks for two responses and you provide three responses, then only the first two are scored. If the first response is incorrect, you will not get any credit for that response. Extra points may be available for elaboration, but only when they are requested.
- **A well-written essay:**
  - Presents a clear thesis statement on the topic and stays focused on the main idea throughout the essay
  - Develops the essay in an organized, logical sequence—introduction, body, and conclusion
  - Uses smooth transitions that flow from one paragraph to another
  - Supports the main idea with relevant and specific supporting evidence, details, technical terms, and examples
  - Responds to all parts of the essay question

## Helpful Hints

- Define and/or explain any scientific technical terms you use. Write an example or provide a description of each of the important terms that you use to prove to the grader that you understand the terms. Rarely would the exam ask for a list of scientific buzzwords, and one- or two-word answers do not demonstrate a depth of knowledge about the topic.
- Write clearly and neatly. If the grader cannot read your answer because of poor penmanship, you may receive a zero for your response.
- Provide details about the subject, and be sure to stay focused on the topic. Provide supporting evidence that is relevant to the topic (for example, “light is necessary for photosynthesis”). Points will be given if you show your basic knowledge of the topic.
- If you cannot remember the definition of a term, take a shot at it with an educated guess. You may surprise yourself with information stored in your long-term memory. After writing a few words, your memory may be triggered to remember facts that will help you describe the term. Even if you cannot remember the name of a concept or term, by providing a description you may at least be able to receive partial credit.
- Be concise and precise. This is a science test, not an English test.
- Manage your time wisely. Do not waste time adding any unnecessary information. Avoid restating the question—doing so will only use up valuable time. Stay on task. Credit is only given for information requested.