11 Must Know AP Environmental Science Concepts

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Introduction

AP Environmental Science is an interdisciplinary course with great potential impact for students. Like all AP courses, you can save time and tuition by earning AP credit and positioning yourself to thrive in college. Uniquely, APES can prepare you to take action on important environmental issues in your everyday life.

Since this is a big opportunity, we’ve put together an eBook which is packed with helpful crash courses on some central APES topics.

It’s useful as an early year primer, a supplement to your teacher’s instruction, and as a review packet in the spring. Much of the information contained here is from the Albert Blog. If you’re looking for additional help in preparing for the APs, be sure to regularly check the blog, and subscribe to hear about our new posts.

E-mail us at hello@albert.io if you have any questions, suggestions, or comments!

Last Updated: September 2016

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About Us

What is Albert?

Albert bridges the gap between learning and mastery with interactive content written by world-class educators.

We offer:

• Tens of thousands of AP-style practice questions in all the major APs
• A complete competitive online leaderboard to see where you stand compared to others
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Why Educators Love Us

We asked teachers how their students did after using Albert.

Here is what they had to say:

My students had an 81.2% passing rate - the previous year was 76% (the highest rate in our county)! I am thrilled. I had 64 students total, with 6 receiving 5s, 19 scoring 4s, 27 receiving 3s, 10 scored 2s and 2 received 1s.

Susan M., JP Taravella High

70% of my students scored 3 or higher. This is up from last year, and is also well above the national average. Needless to say, I am very happy with my students' success. I used Albert more intentionally this year. In the beginning of the year, I wanted students simply to answer questions and practice. Once they had 150-200 questions answered, we looked for trends, strengths, and weaknesses and worked on addressing them. Students were tasked with increasing their answer accuracy no matter how many questions it took, then they set their own goals (some wanted to focus around tone; others needed practice with meaning as a whole).

Bill S., Lapeer High School

Last year 40% passed with 3s and 4s. This year 87% passed, most had 4s and 5s. We used the stimulus-based multiple choice questions throughout the year and as review for the exam. I think it helped tremendously.

Alice P., First Baptist Christian Academy

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Why Students Love Us

We asked students how they did after using Albert.

Here is what they had to say:

I scored very well this year – four 5s and one 4. Albert helped me get used to the types of questions asked on the exam and overall my scores were better this year.

Robyn G., Chambersburg Area Senior High School

Last year was my first year taking an AP test, and unfortunately I did not do as well as I had hoped. The subject had not been my best, and that was definitely displayed on my performance. However this year, I made a much higher score on my AP test because Albert pushed me to focus on my weaknesses and form them into strengths.

Charlotte R., Rome High

Albert allowed me to get extra practice and be exposed to questions similar to that on the AP exams. Overall, I did great this year with passing all my exams with 5's and 4's!

Shwan N., Central Gwinnett High School

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Biodiversity: AP Environmental Science Crash Course Review

In this AP Environmental Science crash course review, we will tackle what biodiversity is, what you need to know about it, and why it is important for the APES exam.
What is Biodiversity?

Biodiversity refers to the variety of life on planet Earth at all of its levels. It is used to describe the number and variety of organisms that are found within a specific region, ecosystem, or on planet Earth. It includes everything from rare and endangered species to common species you see all the time to fungi and microbes that we know very little about. It is important to specify what aspect you are thinking of when discussing biodiversity because it can be discussed in many different aspects.

Ecosystems that have high levels of biodiversity have a large number of species, complex food webs, a variety of ecological niches, increased genetic diversity, and abundant resources.

Evolution

Biodiversity is the result of evolution. Evolution can be defined as the changes in a population’s genetic composition that occurs over time. Evolution stems from a theory developed by Charles Darwin that specified not only that species evolve, but also how they evolve. Darwin specified that organisms produce similar organisms, but natural selection determines what traits are passed on to the next generation. Through the process of natural selection, only the fittest animals survive to adulthood and reproduce. The reproduction process then passes on desirable characteristics that helped these animals survive to reproductive age. If organisms have a trait that helps them successfully compete with other individuals in the population, this trait is more likely to be passed on. If enough time is given, species will change and evolve as they acquire more favorable traits and abandon less favorable traits. Variation of traits in a generation often looks like a bell shaped curve. Fewer individuals have one extreme or the other - most individuals are somewhere in the middle.
Biodiversity: AP Environmental Science
Crash Course Review Cont.

Natural selection can impact populations in several ways. Directional selection occurs when an environmental change gives advantages to a variation that occurs on one end of the bell curve. An example of this is the fact that giraffes with long necks can more easily get food. Stabilizing selection occurs when the selection process favors the average member of a population. An example of this is the color of squirrels. In most areas, the vast majority of squirrels are grey because it helps them blend in. Red, black, and white squirrels are more likely to be eaten and thus not pass on their characteristics. Disruptive selection is selection that favors the extremes of a population and not the average. Disruptive selection is different than directional selection because it favors both ends of the bell curve and not just one. A common example of this is the peppered moths. In London, most of the moths were light-colored. In industrialized areas, dark colored moths were more likely to survive, leading to a higher concentration of dark colored moths.

New species can also be created through isolation when populations become separated. Isolation can be geographic- when a geographic barrier separates a population- or reproductive- when members of a population cannot freely reproduce with all other members of the population.

Why is Biodiversity Important?

It is important because it offers many benefits to human populations, animal populations, and the environment. It provides food, drugs and medicine, products, ecological benefits, and aesthetic and cultural benefits. Over 80,000 plants are edible for humans and many varieties of animals are edible as well. Drugs and medicines are also a significant benefit of biodiversity. Around 50% of drugs and medicines come from natural products and there are significant possibilities for developing new medicines from natural sources. Products provided as a result of ecosystems include timber and other natural resources. Ecological benefits include natural pest control, soil formation, waste disposal, air and water purification, and many others.
Animals benefit from biodiversity in the form of increased food sources. A large number of plant and animal species provides options if one food source is wiped out or is otherwise reduced in number. It is also good for the environment. Many varieties of plants and animals help keep ecosystems functioning well in the event of disease, pests, climate change, and other environmental hazards.

**Threats to Biodiversity**

Despite the fact that biodiversity brings many benefits to humans, there are many threats to it, many of which are increased by human activities. The largest threat is habitat destruction, which is primarily a result of human activity. Deforestation, the creation of dams in waterways, and draining wetlands all contribute to habitat loss and destruction. Other threats to include pollution, excessive hunting and removal of plants and animals, and climate change.

**Biodiversity on the AP Environmental Science Exam**

You will see questions dealing with biodiversity on all parts of the AP Environmental Science exam. Biodiversity and its related topics are an important focus of the APES class and exam. Below, we will walk through a free response question from the 2013 AP Environmental Science Exam.

*Biological diversity, or biodiversity, has become a topic of great concern among conservationists. Biodiversity is often used by scientists and policy makers to help determine the health of ecosystems.*

(a) Describe TWO characteristics shared by ecosystems that have high biodiversity.

(b) Identify TWO specific human activities that result in a loss of biodiversity, and explain how each activity lowers biodiversity.
Biodiversity: AP Environmental Science
Crash Course Review Cont.

(c) For each human activity you discussed in (b), propose a practical strategy (other than simply banning the activity) to reduce the loss of biodiversity.

(d) Describe ONE naturally occurring factor that could lead to a loss of biodiversity.

(e) Describe TWO ecological benefits that greater biodiversity provides.

In part (a) of this question, you can earn two points- one for each characteristic of ecosystems that have high biodiversity. You can state that ecosystems with high biodiversity have a large number of species, have greater genetic variability, or have greater amounts of natural resources. Since there are several correct answers, this part of the question can easily be answered even if you don’t remember all of the features of an ecosystem with high biodiversity.

Part (b) of this question also offers two points. One for each human activity and its corresponding explanation. If you leave an incorrect or incomplete explanation, you will not receive full points. Since there are also many correct answers to this part of the question, you have options. You might cite the use of monoculture farming techniques and the fact that they eliminate native species and decrease genetic variation. You might also cite overhunting, which harms biodiversity by reducing keystone species.

In part (c) of this question, you need to further apply the answers you gave in part (b) for two additional points. With the examples mentioned above, possible solutions include encouraging polyculture, agroforestry, and intercropping, and regulating hunting activities or imposing quotas. In order to receive full points for this question, you need to correctly link your solutions to the activities you listed in part (b).

In part (d) of this question, you can earn one point. There are also many correct answers to this part of the question. You might cite wildfires, natural long-term climate change, or natural disasters such as hurricanes and tsunamis.
In part (e), two points are available— one for each correct ecological benefit you name. You have a lot of options here as well, which is particularly helpful if you cannot remember all the ecological benefits of biodiversity. Correct answers include pollination, control of pests, and water and air purification.

**Conclusion**

In this AP Environmental Science crash course review, we have covered everything you need to know about biodiversity and helped you understand how to correctly and completely answer questions about biodiversity on the APES exam. By carefully reviewing this information for the APES exam, you set yourself up to approach the AP exam with confidence.
Invasive species are an important subject on the AP Environmental Science exam. In this APES crash course review, we will go over everything you need to know about invasive species for the AP exam, giving you the skills and knowledge you need to correctly answer all questions on the AP Environmental Science exam.
Invasive Species

First: what is an invasive species? It is one that is not commonly found within a given ecosystem and has no predators, giving the species the ability to grow rapidly while damaging native species. An invasive species begins as an alien species and becomes a problem over time as it harms the ecosystem. Invasive species can be either actively or accidentally introduced into an ecosystem, but their introduction is usually a result of human interaction with the environment.

The Importance of Invasive Species

Invasive species are important because they can damage the environment where they migrate. If the alien species fills a needed role in the new environment, it might become very beneficial; however, it can also become a problem if it becomes invasive and is not effectively regulated by other existing species in the ecosystem.

They take needed resources away from other species in the ecosystem and create competition. This competition can result in challenges for other species and subsequent population decline. In this way, invasive species can threaten biodiversity.

Invasive Species Population Growth

Invasive species tend to be strategists, meaning that they have high birth rates, have many offspring in a generation and have short life spans. Their survival is dependent on quick and exponential growth. This exponential growth rate limits the ecosystem’s ability to control their growth.
Examples of Invasive Species

One example is the zebra mussel. Introduced into the Great Lakes through foreign freight ships, the zebra mussel has become an invasive species. Since the zebra mussel has no natural predators in the Great Lakes, it has taken over, clogging the intakes to power plants and causing other issues in the Great Lakes.

Image Source: Flickr

Invasive Species on the AP Environmental Science Exam

On the APES exam, you will likely see questions about invasive species both on the multiple-choice section of the exam and on the free response part of the exam.

On the multiple-choice section of the exam, the key to success is the ability to recognize the correct answer from a list of options. Familiarizing yourself with invasive species and other features of ecosystems will set help you set yourself up for success in this area of the exam.
Invasive Species: AP Environmental Science Crash Course Review Cont.

On the free-response section of the exam, you will need to integrate your understanding of invasive species with other concepts and terms related to ecosystems to correctly answer free response questions.

AP Environmental Science Free Response Question Example

To help you prepare for the AP Environmental Science free-response questions about invasive species, below is a previous free response question from 2010 that we will break down and answer to help you prepare for the exam.

The zebra mussel, a mollusk native to Eurasia, was first discovered in the Great Lakes of North America in 1988. Zebra mussels attach to solid substrates and are filter feeders. Adult zebra mussels can survive for several days or even weeks out of water if the temperature and humidity are favorable. An adult female zebra mussel can produce as many as one million eggs per year. The recent range of occurrence of zebra mussels in the United States is indicated by shading in the map above.

(a) Why are zebra mussels located primarily in areas in the eastern United States rather than in the western United States?
(b) How are zebra mussels introduced into isolated lakes? Describe one viable method for preventing the spread of zebra mussels into isolated lakes.
(c) Identify and explain one impact that zebra mussels can have on aquatic ecosystems.
(d) Identify another invasive species, either terrestrial or aquatic, and describe one negative impact it has had.
(e) One strategy for controlling an invasive species has been to introduce another non-native species to control it; this strategy can often have unintended results. Give a specific example of the use of this strategy and discuss a negative impact of introducing a nonnative species to control an invasive species.

(f) Discuss TWO specific characteristics of invasive species that enable them to thrive in new environments.

Note that there are twelve specific pieces of information you need to provide in order to get full points for this question. Part (a) is worth one point. To satisfactorily answer this part of the question, you might cite that the eastern US has more bodies of surface water for the zebra mussel to live in or that since zebra mussels were introduced in the eastern US, they have not had significant opportunity to spread yet.

For part (b), note that there are two parts you need to answer. First, you need to explain how zebra mussels are introduced into isolated lakes. To answer this part of the question you might cite the transportation of boats and boat trailers with attached mussels or the inundation of flood waters from lakes infested with zebra mussels. For part two of question b, you need to address one way to prevent the spread of zebra mussels. Acceptable responses include requiring boats to be thoroughly cleaned before transport and increasing education about zebra mussels to boaters and other individuals who are likely to transfer zebra mussels.

Part (c) is worth two points. For the first part, you need to identify an effect that zebra mussels have on aquatic ecosystems and for part two you need to explain it. Valid answers include increased competition in the ecosystem resulting in decreased populations of native organisms and a disruption of the natural food chain because zebra mussels eat what other organisms would be eating.
Invasive Species: AP Environmental Science Crash Course Review Cont.

Part (d) is also worth two points and requires some general knowledge of other invasive species. It asks you to name one and the impact it has on the ecosystem. You might cite kudzu, a vine that suffocates native plants, the emerald ash borer, which preys on ash trees, or another invasive species of your choice and the impact it has on the local ecosystem.

Part (e) is also worth two points and requires some general background on invasive species. To earn both points, you need to cite a species brought in to control an invasive species and the unintended results. You might cite the Australian cane toad, brought in to control pests and note that it became an invasive species itself.

For part (f), you need to discuss two specific characteristics that allow invasive species to thrive in new environments. For this question, you might talk about invasive species being r strategist organisms and having superior defenses against predators in a new environment.

After completing part (f), you have successfully completed the question and earned all twelve points. As you can see for this example question, a general understanding of invasive species, along with a few examples of invasive species memorized, provides you all the necessary knowledge you need to know to correctly answer questions about invasive species on the AP Environmental Science Exam.

This AP Environmental Science review has provided you everything you need to know about invasive species for the APES exam. A careful review of this information and practice with invasive species will set you up for success on the AP Environmental Science exam.
Ready to get a 5?

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Start Practicing
If you have been reviewing ecosystems for the AP Environmental Science exam, you may have run into the term keystone species. In this AP Environmental Science review and study guide, we’ll break down what keystone species are, why they are important, and everything you need to know to answer questions about on the AP Environmental Science exam.
Keystone Species

First: what is a keystone species? It is one that maintains the entire balance of a particular community. Named after the last stone placed in an arch, which keeps the arch standing, the keystone species similarly maintains the balance of the ecosystem and maintains the biodiversity an ecosystem through the role it plays. When a keystone species is removed from its ecosystem, the whole ecosystem is changed. The extinction of these species leads significant changes in the ecosystem.

Keystone Species Characteristics

A keystone species is typically a predator, though it can also be an engineer, and does not need to have a large population to control the ecosystem. A mountain lion, for example, can cover an expansive area, controlling the population of other smaller animals by eating them. Non-keystone species will often adapt their behavior around the keystone species.

The Effects of Keystone Species Elimination

The main effect of the disappearance of a keystone species is a significant change in the ecosystem. For a keystone predator species, this significant change will be an increase in the populations of the predator’s food sources. With the mountain lion example above, the population of small mammals would increase if the mountain lion disappeared. These uncontrolled populations might overgraze on the area’s plant life, resulting in a decrease in biodiversity and a scarcity of resources for other species. For an engineer keystone species, the environment will change because the keystone species is no longer engineering their environment.
The elimination of a keystone species can also leave an ecosystem open to an invasive species. An invasive species that would have previously been controlled by the keystone species would not experience this same resistance if the keystone species were eliminated.

**Herbivore Keystone Species**

These species do not always need to be predators; they can also be engineers. The herbivore elephant is an example of a keystone species in African savannas. Elephants eat small trees and other plants, which keeps the savanna a savanna instead of allowing it to become a forest. Even if a tree gets to be sizable, the elephants’ large size gives it the ability to knock it over and eat it. Without the elephants to control the tree population, grazing animals like antelopes and zebras would experience more competition for food since they eat grasses. Mice and small rodents depend on the savannah being a grassland to have spaces to burrow into the soil. Lions and other carnivorous animals depend on the grazing animals for prey. Without elephants in this ecosystem, trees would grow up and push out grazing animals, making significant changes in the savanna ecosystem.

**Wolves in Yellowstone National Park**

A prominent example of a keystone species in the United States that you may encounter on the AP Environmental Science exam is the grey wolf. Until the early 1900’s, grey wolves were relatively unthreatened and were a keystone species. Grey wolves would kill elk and deer, leaving their carcasses and providing food for scavengers. As people moved west and set up farms, wolves became unpopular. The grey wolves would kill livestock, leading farmers to shoot them. By the early 1900’s, wolves were eliminated from Yellowstone National Park. Since the wolves are a keystone species, the ecosystem underwent significant changes which led to a large increase in the number of herbivores in the park. These herbivores consume more plants as they increase in number, which leads to less plant diversity and periodic starvation for herbivorous species.
Keystone Species: AP Environmental Science Crash Course Review Cont.

In 1995, several dozen grey wolves were captured in Canada and reintroduced to the park. Because grey wolves are native species to the area, the wolves did well, reproducing and increasing their number. Combined with bans on hunting, the wolves have since grown back into the keystone species they once were and are effectively controlling the ecosystem at Yellowstone National Park.

Keystone Species on the AP Environmental Science Exam

On the APES exam, you will likely see multiple choice questions that directly ask about keystone species. Familiarity with the definition, as well as some examples of keystone species, will help you to answer these questions correctly.

In the free response section of the test, you will also see questions that deal with keystone species, but they may not directly ask about them. You will need to combine your knowledge with other information about ecosystems to adequately answer these questions. Below, we will break down a free response question that involves keystone species with how you might go about answering it on the APES exam.

Humans have spent over 100 years and billions of dollars trying to drive various species of mosquito to extinction. Despite the inventions of pesticides and the ensuing mass spraying of these chemicals, mosquitoes remain a human health threat. In contrast, we are experiencing the near extinction some species of elephants, despite our efforts to conserve them. The primary reason for this contradiction is that the mosquito is an r-selected species, and the elephant is a K-selected species.

a. How do an r-selected species and K-selected species population growth rates differ?
b. What are the patterns of variation in population size for both creatures?
c. What are their frequencies of reproduction?
d. How many offspring do they both have?
e. How does this relate to their present risk of extinction?

As you can see, this question does not directly ask about keystone species, but the elephants referenced in the question are keystone species.

For part (a) of this question, you need to understand r selected and k selected species. R-selected species grow at exponential rates very quickly, have short lifespans, and have a large number of offspring. Among K-selected species, populations take longer to grow, have longer lifespans and have few offspring. The keystone elephants and many keystone species are k selected while the mosquitoes are r selected.

Part (b) also deals with r and k selected species. R-selected species have populations that vary more widely because they typically have larger numbers of individuals to begin with. K-selected species have fewer variations and are more susceptible to decreases in population because they have fewer offspring.

Part (c) addresses reproduction of each species. The keystone elephants in the question have a long gestational period, leading to a slow frequency of reproduction. In contrast, the mosquitoes have a short gestational period, resulting in rapid reproduction.

Part (d) addresses how many offspring each species has. Since the elephants have a long gestational period, they have relatively few offspring. The mosquitoes, on the other hand, have many offspring enabled by their short gestational period.

Part (e) asks you to combine this information and reflect on the risk of extinction for each species. Due to the short gestation period and a large number of offspring, mosquitoes are unlikely to become extinct. In contrast, the keystone elephants are vulnerable. Their long gestational period and limited offspring leave them more susceptible to extinction.
Keystone Species: AP Environmental Science Crash Course Review Cont.

In this APES crash course review, we have covered what keystone species are, how they function in their ecosystems, some examples of keystone species, and how to answer questions involving keystone species on the AP Environmental Science exam. A solid understanding of this information will set you up for success on the AP Environmental Science exam.
If you have been studying for the AP Environmental Science exam, you have probably heard the term biomes in your studying, but you might not have a complete understanding of what biomes are and why they are important in APES. In this AP Environmental Science study guide and review, we will break down just what biomes are and everything you need to know about them to succeed on the APES exam.
Biomes

First: what is a biome? A biome is a large, relatively distinct, regional type of ecosystem with a distinctive climate, soil conditions, and a biological community adapted to those conditions. There are seven major types of biomes including the coniferous forest, temperate deciduous forest, desert, grassland, rainforest, shrubland and tundra each with unique features, though it is important to note that biomes blend in places and these blended areas also have specific names. It is not important to remember specific names of these mixed biomes, but it is important to keep in mind that they exist.

Types of Biomes

The coniferous forest is named for coniferous evergreen trees, meaning trees that produce cones and needles, many of which retain their needles all year long and are the most common vegetation in this biome. Winters are cold and snowy, and summers are warm and humid, with four distinct seasons. Most precipitation in this biome falls as snow. Mammals and birds are the prominent animals in this biome.

The temperate deciduous forest is named for its deciduous trees, meaning that the trees lose their leaves in the fall and grow back in the spring. Featuring four distinct seasons with temperatures that vary between cold temperatures in the winter and hot temperatures in the summer, the temperate deciduous forest features a wide variety of broadleaf trees, shrubs, and perennial plants as well as mammals and birds that are adapted to wide changes in temperature.

The main feature of the desert biome is that it is the driest biome. Deserts can be cold or hot and have a wide variation in temperature due to the dry air.
Vegetation in deserts is limited to cacti, bushes, and grasses that can withstand the limited water either by conserving water well or thriving only when water is available. Mammals are limited to reptiles and small rodents that are well adapted to conditions with limited water.

Grasslands are flat and bordered by temperate forests at higher latitudes and deserts at lower latitudes. The grassland biome can be found on all continents except Antarctica and grasslands can be warm, with wet and dry seasons, or temperate, with distinct seasons. The dominant vegetation is grasses, ranging from tall grasses with deep roots to shorter grasses with shallow roots. The dominant animals are large mammals and migratory birds.

Rainforests can be tropical or temperate, but must remain warm and frost free. They receive high levels of precipitation and have high levels of vegetation including palms, ferns, and vines. Rainforests feature a long growing season and have a large variety of animals including birds, insects and reptiles.

Shrubland occurs in coastal areas in relatively warm climates between 30 and 40 degrees north and south latitude. These areas receive more rain than deserts, but less rain than forests with noticeable wet and dry seasons. Shrubs and short trees are the dominant vegetation and animals include mammals, reptiles, and birds.

Tundra is the coldest biome and features very few if any trees due to permafrost and an incredibly short growing season. The dominant vegetation is low-growing plants that can grow in a few inches of soil that is thaws out for part of the year. There is low precipitation, most of which is snow. Animals are limited to large mammals and birds that are well adapted to cold and snow.
Biomes: AP Environmental Science Crash Course Review Cont.

Tips for Approaching Biome Questions on the APES Exam

Now at this point, you may be wondering: how am I ever going to remember all of these details, especially with everything else I need to study for the APES exam? And that is a good question, but the truth is that you only need to have a general understanding of each biome and its characteristics to be successful on the AP Environmental Science exam.

For the APES multiple choice section, you only need to be able to recognize the correct answer among a list of options. Using effective test taking strategies like the process of elimination will help you choose the right answer if you have a general understanding of biomes or even if you find yourself stuck on a question.

For a free response question regarding biomes on the AP environmental science exam, a general background about biomes and an understanding of each biome is sufficient to do well on the exam.

Important Things to Know

For each of the major biomes, you should know where they occur on the world map. You should also be able to describe major characteristics of the biome including animals, plants, temperature and precipitation. For temperatures and precipitation, a general idea of the quantitative measures is helpful, but you do not need to memorize a specific range. Instead, focus on knowing what kind of temperatures the biome experiences and have a general idea of how much precipitation falls in the biome.

Vocabulary

There is also some general vocabulary that will be important to know for the APES exam in addition to the biome definitions above.
This vocabulary will enable you to discuss biomes with confidence on the exam. These terms include:

- **Climate**: the average and typical weather conditions in a given area over an extended period. Climate is influenced by latitude, terrain, altitude, and nearby bodies of water.
- **Rainshadow**: the dry area on the leeward (back side) of a mountain. Rainshadow occurs because the mountain blocks rain-producing weather systems from passing over the mountain.
- **Windward**: front side of a mountain.
- **Leeward**: back side of a mountain.
- **Latitude**: lines of latitude run parallel to the equator and indicate how far north or south a location is from the equator.
- **Altitude**: refers to how high a given location is above sea level.
- **Primary Succession**: occurs when there is no soil or plant life in an area, such as when a volcano erupts and coats the land in lava, and plant life slowly begins to move in and create soil by breaking down rocks.
- **Secondary Succession**: occurs when a natural disaster devastates an area but leaves existing soil and some plant life.

This vocabulary is of particular importance in the free-response section of the exam. It allows you to relate biomes to each other as well as discuss biome related subjects such as how humans and natural disasters have an impact on biomes.

This AP Environmental Science review gives you everything you need to know to have a good background on biomes. Practicing this information and studying the included vocabulary will provide you with everything you need to approach all the biomes questions on the AP environmental science exam with confidence.
If you have been reviewing for the AP Environmental Science Exam, you probably have come across the nitrogen cycle, but you may not have a good understanding of what it is and why it is important for the APES exam. In this AP Environmental Science crash course review, we will explain the nitrogen cycle, why it is important on the APES exam, and review a free response question about the nitrogen cycle. Let’s get started.
Nitrogen Cycle: AP Environmental Science Crash Course Review Cont.

What is Nitrogen Cycle?

The nitrogen cycle is the process which converts nitrogen from its inert atmospheric form (N2) into usable forms for life on earth. The nitrogen cycle occurs both on land and in the water. Nitrogen is essential to life on earth because it creates the building blocks of proteins and nucleic acids such as DNA. While nitrogen is the most prominent element in the atmosphere at 78%, it is of very little use until it is transformed into other forms. As part of other substances, it becomes useful for life.

The nitrogen cycle is composed of several steps, which we will discuss in detail in the following sections.

Stages in the Nitrogen Cycle

Nitrogen Fixation

Nitrogen fixation is the process of transferring nitrogen from its inert atmospheric form (N2) into an organic or fixed form. Nitrogen can be fixed in several different ways, but is primarily fixed through biological processes.

First, nitrogen leaves the atmosphere and is deposited into soil and surface waters through precipitation. After landing in soil and surface waters, nitrogen undergoes changes to become ammonia. The two nitrogen atoms separate and combine with hydrogen, creating ammonium with the chemical equation NH4+. This process is caused by bacteria that are symbiotic with certain plants, free anaerobic bacteria, and algae. Plants that facilitate this process include alfalfa and beans, which are often planted to remediate nitrogen poor soil and rotated with crops that remove nitrogen from the soil. Nitrogen fixing bacteria use an enzyme called nitrogenase to split inert nitrogen molecules into individual atoms that can be combined into other usable compounds. This process is called biological fixation.
Nitrogen is also fixed in small amounts through lighting strikes in a process known as abiotic fixation. The high energy of the lightning strike converts atmospheric nitrogen into ammonia (NH3) and nitrates (NO3-). Abiotic fixation accounts for about 10% of nitrate entering the nitrogen cycle. Nitrogen is also fixed through manmade processes including the creation of nitrogen-based fertilizer and commercial manufacturing processes that produce ammonia.

**Nitrification**

Nitrification occurs when nitrifying bacteria convert ammonia first into nitrite (NO2-) and then secondly into nitrate (NO3-). The importance of this process cannot be understated because ammonia is highly toxic to most organisms and can only be used by some types of plants. Nitrifying bacteria are crucial to changing nitrogen into a useable form for most living creatures.

**Assimilation**

During the assimilation process, plants take up nitrogen compounds from the soil and then turn them into proteins. Nitrogen compounds come in multiple forms including nitrate, nitrite, ammonia, and ammonium. Since other organisms cannot absorb nitrogen in the same manner as plants, they rely on consuming plants and other animals in order to get the nitrogen they need.

**Ammonification**

Ammonification is the process that allows nitrogen from living creatures to be transmitted back to the soil. This occurs through the production of plant and animal wastes as well as when plants and animals die. The nitrogen in this organic matter is then broken down by decomposer microorganisms. These microorganisms produce ammonia, which then becomes available again for biological processes.
Denitrification

In the denitrification process, nitrogen moves back into the atmosphere. Nitrate (NO3-) is converted back into inert gaseous nitrogen (N₂). The denitrification primarily occurs in soils where oxygen is limited due to water. Waterlogged fields and soils with high clay content are especially vulnerable. Denitrifying bacteria process nitrate to get oxygen. As a byproduct of this process, free nitrogen gas is created.

Image Source: Wikimedia Commons
Human Impact on the Nitrogen Cycle

Human activity is frequently the cause of an upset in the balance of the nitrogen cycle. Humans can either remove nitrogen from ecosystems or add excess nitrogen to the system. Both of these actions result in significant changes to the ecosystem. Examples of human activity that removes nitrogen from the system includes destroying forests and removing plants from ecosystems, thus reducing organic nitrogen sources. Not rotating crops can also cause a depletion of nitrogen if the crops are not fertilized properly.

Human activities that add excess nitrogen to the nitrogen cycle include the use of most commercial fertilizers used in food production, the discharge of human waste and sewage into aquatic ecosystems, and the emission of nitrogen dioxide by cars and power plants.

Most commercial fertilizers add too many nitrates to the ecosystem and are easily washed into local aquatic ecosystems, which can cause eutrophication, which occurs when too many nutrients are added to water, resulting in dense plant growth that chokes out animals. Algal bloom is similar to eutrophication, but focuses on an overgrowth of algae. Algal blooms occur when too much nitrogen is added to the water and algae thrives. Increased algae lead to a decrease in the growth of other organisms in the environment. The discharge of human waste and sewage into aquatic ecosystems has a similar effect on aquatic ecosystems.

Automobiles and power plants also emit nitrogen dioxide into the atmosphere. The nitrogen dioxide then reacts with the oxygen, especially on hot summer days, forming ozone, which remains in the lower levels of the atmosphere. The ozone is highly reactive and detrimental to living organisms. In humans, the ozone exacerbates respiratory conditions.
The Nitrogen Cycle on the AP Environmental Science Exam

At this point, you may be feeling overwhelmed and wondering how to approach questions about the nitrogen cycle on the APES exam. In the multiple-choice section of the AP Environmental Science exam, you only need to recognize the correct answer among a list of choices, meaning that a general understanding of the nitrogen cycle will equip you to correctly answer multiple choice questions about the nitrogen cycle. In the free-response section of the exam, you may find a question that asks about the nitrogen cycle, but it will require a greater understanding of the nitrogen cycle and likely ask you to apply your knowledge about the nitrogen cycle. To prepare you to answer questions like this, we will break down a sample question about the nitrogen cycle below.

The following is a question from the 2009 AP Environmental Science Exam. The directions are to read the article below from the Freemont Free Press and answer the questions below.

*Freemont City Council Considers Nitrogen Ban to Fight Smog!*

At Tuesday’s council meeting, Susan Lanza, a local environmental scientist, spoke about the role that nitrogen compounds play in the photochemical smog episodes that have recently plagued Fremont. Noting how successful the ban on phosphate detergents had been in improving the conditions in Lake Fremont, Councilman Peter Bud proposed a ban on the use of all nitrogen-containing fertilizers in Fremont to solve the local photo-chemical smog problem.

Councilwoman Nita Smith made a statement that “although nitrogen-based fertilizers can cause other environmental problems, the ban on nitrogen fertilizers won’t solve the smog problem in Fremont.” After a heated discussion, the council tabled the motion on the ban.
(a) Support Councilwoman Smith’s statement that nitrogen-based fertilizers cause other environmental problems by describing one such problem.

(b) Identify a nitrogen-containing primary pollutant that contributes to the formation of photochemical smog. Describe how that primary pollutant forms and explain why Councilman Budd was wrong.

(c) Identify one secondary pollutant that is a component of photochemical smog and describe the following.
   (i) How the secondary pollutant forms
   (ii) ONE human health effect of the pollutant
   (iii) One environmental effect of the pollutant

(d) Earth’s natural nitrogen cycle occurs in several steps. Describe one chemical transformation that occurs in the natural nitrogen cycle and discuss the importance of that transformation to an ecosystem.

In part (a) of this question, two points can be earned for correctly describing the cause and effect of one environmental problem related to nitrogen-based fertilizers that is not related to photochemical smog.

There are several causes and effects you can choose to correctly answer the question. You might talk about fertilizer entering groundwater and surface water. Correct effects for this cause include increase in algal blooms in surface waters, decreased dissolved oxygen levels in surface waters, promotion of eutrophication in surface waters, and nitrate contamination of drinking water.

Another cause you could cite in part a is bacterial decomposition of fertilizer. Two correct effects of this cause include the production of nitrous oxide that increases global warming and the production of N2O which depletes stratospheric ozone.
Another cause you could cite to answer this question correctly is the production, transportation, and application of the fertilizer. Effects of this cause include consuming fossil fuels and the resulting habitat destruction that occurs when fossil fuels are extracted and consuming fossil fuels, which produces carbon dioxide and increases global warming.

In part (b) of this question, three points can be earned. One for identifying a primary pollutant that contains nitrogen; one for describing how that primary pollutant is formed; and one for an explanation of why Councilman Budd was wrong.

You might choose several different primary pollutant including nitric oxide (NO), nitrogen dioxide (NO2), or nitrogen oxides (NOX). You then need to explain how these are formed. Nitrogen reacts with oxygen \((N2 + O2 \rightarrow 2NO)\) or \((N2 + 2O2 \rightarrow 2NO2)\) or nitric oxide reacts with oxygen \((2NO + O2 \rightarrow 2NO2)\). These reactions occur during high-temperature combustion, combustion in automobile engines, combustion in power plants that burn fuel, and as a result of burning fossil fuels. Your third point can be earned by explaining that nitrogen-based fertilizers do not release the air pollutants that cause photochemical smog, thus explaining why Councilman Budd was wrong.

For part (c) of this question, you can earn four points: one for identifying a secondary pollutant; one for describing the formation of that pollutant; one for describing a correct human health effect; and one for describing a correct environmental effect.

You have several options for identifying a pollutant. Two include nitrogen dioxide and nitric acid. Nitrogen dioxide is formed by the reaction of nitrogen oxide with oxygen, and nitric acid is formed from a reaction of nitrogen oxides with oxygen and water vapor.
Nitrogen Cycle: AP Environmental Science Crash Course Review Cont.

A human health effect from nitrogen dioxide is respiratory problems, and a human health effect from nitric acid is damage to the lungs when inhaled. An environmental effect of nitrogen dioxide is reduced visibility and impaired photosynthesis. An environmental effect of nitric acid is reduced soil fertility.

In part (d) of this question, two points can be earned. The first is for describing a correct natural chemical transformation in the nitrogen cycle. The second is for the corresponding discussion of its importance to an ecosystem.

You can choose any chemical transformation in the nitrogen cycle to answer this question correctly. For this example, we will use nitrogen being converted to nitrogen gas or NO₃ → N₂. The impact on the ecosystem for this transformation is that terrestrial nitrogen is converted back into atmospheric nitrogen, continuing the nitrogen cycle.

In this crash course review, we have reviewed the nitrogen cycle and what you need to know about it for the AP Environmental Science exam and walked through a previous free response question involving the nitrogen cycle.
In reviewing for the AP Environmental Science exam, you have probably come across the term ozone, but you might not completely understand what it is and why it is important for the APES exam. In this crash course review, we will go over what ozone is, why it is important for the AP Environmental Science exam, and review a sample free response question from a previous APES exam.

*Image Source: Wikimedia Commons*
Ozone: AP Environmental Science
Crash Course Review Cont.

What is Ozone?

It is a toxic, unstable gas with a pungent odor and is formed through a reaction of oxygen with electrical discharges or ultraviolet light. It is different from normal oxygen because it has three oxygen atoms. It occurs both in the atmosphere and at lower altitudes.

Why is Ozone Important?

It is important because in the atmosphere, it protects life on earth from the Sun’s harmful UV radiation. About 90% of the ozone in the atmosphere is in the stratosphere, an area of atmosphere that is between 10 and 50 kilometers in altitude. It is created in the atmosphere through a delicate balance of sunlight that creates it and chemical reactions that destroy it. Sunlight splits the oxygen we breathe, O₂, into single atoms. These single atoms can rejoin to make O₂ or combine with O₂ to make ozone. It is decomposed when it absorbs UV light, leaving one O₂ molecule and one O atom. Molecules containing nitrogen, hydrogen, chlorine, and bromine all destroy ozone. This process occurs naturally, but is exacerbated by humans.

In the atmosphere, it limits ultraviolet radiation from the sun. Without it, the earth would be sterile. All UV-c and most UV-b is screened out. About half of the UV-a radiation is screened out. Excessive UV-a and UV-b radiation cause sunburn, skin cancer, eye damage, and other health problems for humans.

Ozone at the Ground Level

At the ground level, it is harmful to life on earth because it is toxic. It is formed at ground level when nitrogen oxide gases, which are produced through vehicle and industrial emissions, react with volatile organic compounds (VOCs).
Volatile organic compounds are carbon containing compounds that easily evaporate into the air, an example being paint thinners. The concentration at ground level can easily become irritating, particularly for those with throat or lung conditions, in cities and industrial areas when the atmosphere is warm and stable.

**The Dobson Unit**

The Dobson Unit is the most commonly unit used for measuring ozone concentration. One Dobson Unit is the number of molecules required to create a layer of pure O\(_3\) that is 0.01 millimeters thick at zero degrees Celsius with a pressure of one atmosphere. Since O\(_3\) is not confined to the stratosphere, the Dobson Unit measures all of it in a column of air to determine it’s thickness, if it were squeezed into a single layer. The average amount of ozone in the atmosphere is about 300 Dobson Units, which is equivalent to 3 millimeters.

**The Ozone Hole**

The ozone hole is an area located over the Antarctic regions where concentration is only 100 Dobson Units. It is not actually a hole, but rather an area of decreased concentration. The ozone hole was not observed prior to 1979, but now comprises most of Antarctica.

The ozone hole comes and goes over the year. It forms at the end of winter and disappears in late November of December. This occurs in conjunction with the appearance and disappearance of sunlight in Antarctica. Due to the location of the Antarctica, portions of the continent do not get sunlight in the winter months and do not get darkness during the summer.
Cause of the Ozone Hole

CFCs, or chlorofluorocarbons, escape into the atmosphere from propellant and refrigeration devices. They are incredibly stable and thus persist in the lower atmosphere for years. Because they are so stable, some of them eventually reach the stratosphere where ultraviolet light can break them down, freeing up the chlorine atom to destroy ozone. However, this destruction does not happen immediately. In fact, the free chlorine becomes part of two chemicals that are considered long term reservoirs for chlorine under normal atmospheric conditions.

The issue arises due to the unique atmospheric conditions in Antarctica over the winter. The polar vortex, an endlessly circulating whirlpool of stratospheric winds, isolates air in the center. The lack of light causes the air to get cold enough for clouds to form, even though the Antarctic air is thin and dry. Chemical reactions take place that convert inactive chlorine reservoir chemicals into active forms, such as chlorine gas. When sunlight returns to the area, UV light breaks up the chlorine gas, freeing it up to destroy ozone, while regenerating the chlorine.

The use of CFCs has rapidly declined as other options have been found to replace them. The Montreal Protocol of 1987 provided a global plan to phase out the use of CFCs and as a result, their use has rapidly declined.

Ozone on the AP Environmental Science Exam

On the AP Environmental Science Exam, you will likely encounter ozone in both the multiple choice and extended response sections of the exam. Having a comprehensive understanding, both in the atmosphere and at ground level will be important to doing well on the exam. Below, we will walk through a free response question that was on the 2013 AP Environmental Science exam.
Sample AP Environmental Science Question

Let’s take a look at an example from the 2013 Free Response section of the AP Environmental Science exam:

Ozone or \( \text{O}_3 \) is an atmospheric trace gas that occurs naturally in the stratosphere. It is also formed as a consequence of human activity in the troposphere, immediately above Earth’s surface. Its location in the atmosphere determines whether the gas protects or damages the environment.

(a) Identify the type of solar radiation that is absorbed by stratospheric ozone, and describe one human health benefit that results from the absorption of this solar energy.

(b) The absorption of solar energy by stratospheric ozone causes molecules to undergo chemical decomposition and formation. Describe the chemical processes that lead to this natural balance between decomposition and formation of stratospheric ozone (you may use chemical equations in your answer).

(c) The Montreal Protocol of 1987 provided a global framework to phase out chlorofluorocarbon (CFC) production and use. Although the Montreal, Protocol has led to a dramatic decrease in CFCs released into the atmosphere, stratospheric ozone destruction has decreased only slightly.

i. Explain the process by which CFCs lead to the destruction of stratospheric ozone. (You may use chemical equations in your answer.)

ii. Explain why the rapid decrease in CFC emissions has not led to a similarly rapid decrease in the destruction of stratospheric ozone.
Ozone: AP Environmental Science Crash Course Review Cont.

(d) Identify a human activity that leads to the formation of tropospheric ozone as a secondary pollutant and explain why tropospheric ozone levels peak in the daytime.

(e) Identify one negative ecological impact and one negative human health impact that result from the formation of tropospheric ozone.

For part (a) of this question, you can earn two points. The first is for identifying solar radiation absorbed by the stratospheric ozone, and the second is for identifying a human health benefit that results from the absorption of this energy. Correct answers include UV-c and UV-b. Human health benefits that result from this absorption include reduced skin cancer, sunburns, and eye damage such as cataracts that are caused by exposure to UV radiation.

In part (b) of this question, two points are available. One for correctly describing the chemical decomposition of the stratospheric ozone and one for correctly describing the formation of stratospheric ozone. Correct answers for the chemical decomposition include UV radiation absorption, which produces an oxygen molecule and an oxygen atom and ozone molecules absorb UV radiation, which produces oxygen molecules. These answers can also be expressed in chemical formulas. Correct answers for the formation of stratospheric ozone include an oxygen molecule reacts with an oxygen atom to form ozone and oxygen molecules absorb UV radiation, which forms ozone molecules. These answers can also correctly be answered with chemical formulas.

For part (c) (i) of this question, two points can be earned. One for correctly describing the decomposition of CFCs and one for correctly describing the reaction of ozone with chlorine. Correct descriptions of the decomposition of CFCs are the absorption of UV radiation by CFC molecules releases chlorine atoms and the chemical formula for this process: $\text{CCl}_3\text{F} + \text{UV} \rightarrow \text{CCl}_2\text{F} + \text{Cl}$. Correct descriptions of the destruction of stratospheric ozone include a written statement that chlorine atoms break down ozone molecules or the chemical formula for this process: $\text{Cl} + \text{O}_3 \rightarrow \text{Cl}_0 + \text{O}_2$. 

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Ozone: AP Environmental Science Crash Course Review Cont.

For part (c) (ii) of this question, you can earn one point for explaining why the rapid decrease in CFC emissions has not rapidly decreased the destruction of stratospheric ozone. There are several correct answers to this question including that CFCs migrate very slowly into the stratosphere, CFCs have a long lifetime in the stratosphere, and that other ozone depleting substances continue to be used.

For part (d) of this question, two points are available. One is for correctly identifying a human activity and a second point is for correctly answering why tropospheric ozone levels are highest during the day. Correct answers to the first part include the burning of fossil fuels and releasing VOCs. Correct answers to the second part of d include the fact that sunlight is needed to form tropospheric ozone and that photochemical reactions create tropospheric ozone.

In part (e) of this question, there are two points available; one for identifying a negative ecological impact and one for a negative human health impact. Correct ecological impacts include reducing photosynthesis, irritating the respiratory system of animals, and that it makes plants more vulnerable to disease and pests. Correct impacts on human health include irritation of the eyes, irritation of the respiratory system, and an association with diseases of the respiratory system.

In this AP Environmental Science crash course review, we have reviewed everything you need to know about ozone for the APES exam and walked through a sample free response question in order to prepare you for the exam.
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Start Practicing
Understanding human populations is an important topic for the AP Environmental Science exam. In this APES crash course review, we will cover everything you need to know about human population for the AP Environmental Science exam in a handy study guide and review sheet. So grab a seat and let’s get started.

Populations

First: you may be wondering what a population is. A population is defined as a group of the same species that lives in the same place at the same time. You probably noticed the “same place” in that definition and are probably wondering how that is defined.
The truth is that this is determined rather arbitrarily. As is evident by the numerous places humans live on this earth, living organisms know no boundaries. A scientist may choose to study a human population in a particular city at a given time, but it is important to note that this boundary is somewhat arbitrary.

**Counting Human Populations**

Human populations are usually determined by a census, or a direct count, of the population. The US government takes a census to establish how many people live in the US. Having a census helps determine the actual size, or the total number of individuals, of a population.

**Population Density**

If you have ever been to a big city, you know that some areas are more densely populated than others. The term population density refers to the number of individuals who are within a given area. Populations density can be uniform, clustered, or random, though human populations are usually clustered or random and not uniform.

A uniform distribution is when individuals are equally spaced apart. This might occur when you are sitting at your desk in AP Environmental Science class. Everyone in your class is sitting at an equal distance from all other students in the class.

Clustered population distributions refer to groups of individuals that are in small, unequal clusters in a given area. An example of this could be your school lunchroom. You might sit with three of your closest friends while the table next to you has twelve people around it.
Random distribution refers to individuals not being grouped in any particular pattern in a given area. An example of this might be the hallway outside your AP Environmental Science class during class change time.

**Human Population Growth**

Human population growth is studied with different equations than other populations. Human population growth typically looks at the start size of the population and then factors that add and take away from the human population. The following equation demonstrates human populations where $N_t$ is the total population size, $N_0$ is the initial population size, B refers to births, I to immigrants, D to deaths, and E to emigrants.

$$N_t = N_0 + (B+I) - (D+E)$$

When studying human populations, we usually do not know what the carrying capacity is or the maximum number of humans that the environment can support. Instead, we refer to crude birth rate, crude death rate, the annual rate of population change, and doubling time to understand the human population.

The crude birth rate is defined as the number of live births per thousand people in a year. It is important to note that this group of a thousand people is not limited only to people who could have children. It also includes men, children, and women who are not of childbearing age. Fertility describes the birth rate per thousand women. Fertility rates are expressed as the general fertility rate, an age-specific fertility rate, the total fertility rate, and the replacement-level fertility rate. All of these rates tend to be higher in less developed countries.

The number of deaths per thousand people in a year is the crude death rate. Death rates are related to nutrition, sanitation, water, hygiene, medicine, and public health.
Improvements in these areas have contributed to a decrease in the death rate in recent history and increased life expectancy for infants and young children.

The annual rate of population change is the birth rate minus the death rate, divided by ten. Population change can be negative, zero, or positive. Negative population change represents more deaths than births in a population. Zero population growth occurs when replacement level fertility is reached, the number of babies born is equal to the number people who die. Positive population change occurs when the number of babies born is greater than the number of people that die.

Doubling time is equal to 70 divided by the annual rate of population change. This equation assumes that the birth rate and death rate are consistent from year to year which is not always the case. Despite this fact, doubling time can give you a general idea of how long it would take the population to double. A helpful hint to remember this for the APES exam to remember the phrase “the rule of 70.”

**Challenges to Studying Human Populations**

Human populations are harder to study than many animal populations. Reliable counts can be hard to come by, humans are free to move about the world, and things like socioeconomic development can also make a difference in human population growth.

Socioeconomic development makes a significant impact on population growth. For instance, developed nations experience lower death rates, lower birth rates, and slower population growth. Less developed countries typically experience higher rates of birth, death, and child mortality. Factors that contribute to these rates include average age of marriage, opportunities for women, access to birth control, and the legality of child labor.
Migration

Humans can also migrate between countries. Countries such as the United States experience a significant amount of population growth from migration whereas other nations may experience a decrease due to migration.

Monitoring migration can be difficult. Though some governments have an organized migration system, others do not. Illegal immigration also raises challenges in monitoring migration.

Structure of the Human Population

Also important for the AP Environmental Science exam is understanding the structure of human populations. The structure of human populations refers to specific features of human populations including age groups, the sex ratio, economic status, geographic regions, and other vital statistics.

An age structure diagram depicts the distribution of a population by age and sex with males on one side and females on the other. Age structure diagrams also illustrate much more than age. They indicate the sex ratio, population booms and growth spurts, and dependency loads. The term dependency load refers to people who are too young or too old to contribute, but still consume resources.

Economic status and geographic regions both influence the structure of human populations. Individual countries can institute policies that favor either population growth or decline. Policies that promote population growth include limiting abortions, housing subsidies that encourage young people to have children, and other incentives for having and raising children. Policies that restrict population growth include one-child laws, raising the legal age for marriage, and limiting incentives to a specified number of children.
Human Population: AP Environmental Science Crash Course Review Cont.

In this AP Environmental Science review, we have broken down everything you need to know about human populations for the AP Environmental Science exam. A thorough understanding of this information will give you the understanding you need to answer all questions on the APES exam related to human populations with confidence.
Waste management is an important topic on the AP Environmental Science exam. In this APES crash course review, we will cover what waste management is, why it is important, and what you need to know about it for the AP Environmental Science exam. Let’s get started.
What is Waste?

Before we can discuss waste management, we first need to understand what waste is. Waste is defined as undesirable materials that result from human activities and processes. Waste is classified into solid and liquid and then into municipal and non municipal.

Municipal solid waste is produced by individuals, households, small businesses, or institutions; is commonly called trash or garbage; and consists of everyday items. The most common municipal solid waste is yard trimmings, paper, plastic, metal, food, rubber, and textiles. Electronic waste or e-waste is also common municipal solid waste and is growing in number. Non-municipal solid waste is solid waste that is produced through the creation of products.

Toxic and hazardous wastes are byproducts of manufacturing that are hazardous or dangerous to the environment or the health of people and animals. Electronic waste is also a source of hazardous waste as there are many hazardous components in e-waste.

Solid Waste in the United States

The United States is the world leader in solid waste production and in the amount of trash produced by weight per person. Much of this waste is unnecessary and could be significantly reduced. Recycling reduces some of the amount of waste produced in the United States, but since not everything can be recycled and some materials, such as plastic, are reduced in quality during recycling, recycling is not the complete answer to the United State’s waste problem.
Waste Management

The term waste management refers to efforts to deal with waste in the most environmentally sensitive way possible. Waste management techniques include waste reduction, composting, recycling, incinerating, and hazardous waste disposal.

Waste reduction is based on the idea that, particularly in developed countries, people and businesses often produce more waste than is strictly necessary. By being mindful of the amount of waste we are producing and reducing it where possible, there will be less waste to manage.

Composting deals with biodegradable wastes including tree trimmings, grass and leaves, and food. These items can be placed in a compost bin and then used for fertilizers when they decompose.

Recycling focuses on turning waste items into new products. Glass, paper, metal, and plastic items can all be recycled and their materials used to make new products.

Incineration occurs when waste is burned. Incineration is used to reduce the original volume of the waste and capture gases that are released when the trash is burned. Incineration poses a threat to the environment and human and animal health when waste has toxic components that are not removed prior to burning.

Hazardous waste disposal deals with safely removing hazardous waste from general solid waste prior to disposal and treating it appropriately. Disposal depends on what the hazardous waste is and how it needs to be treated prior to disposal, but most hazardous waste is placed in long term safe storage.

Integrated waste management uses all of the above methods to effectively deal with waste.
Waste Disposal

There are multiple ways of disposing of waste. Even with waste reduction techniques and integrated waste management, there is still remaining waste that needs to be disposed of. It can be disposed of via incineration or sanitary landfills.

Incineration, which was mentioned above, is the burning of trash. It has quite a few advantages, but has disadvantages as well. Advantages include the fact that incineration reduces the need for landfills, lowers water pollution, concentrates hazardous substances, and produces energy. Disadvantages include the cost to build incinerators, air pollution, difficulty in finding suitable locations for incinerators, the possibility of promoting waste production, and the fact that incinerators compete with recycling for burnable materials.

Difficulties in finding locations for incinerators is known as “Not in My Backyard” and is the idea that most people do not want an incinerator, or a landfill, in their backyard. Wealthier people in society can move to avoid having one in their backyard and thus landfills and incinerators are commonly located in poorer areas.

Sanitary landfills are constructed sites where solid waste is dumped into the ground and then buried. Advantages of sanitary landfills include lack of burning, low odor, low costs, the ability to use the filled ground for other purposes, the large amount of waste they can handle, and the fact that there is no shortage of space in most areas. Disadvantages of sanitary landfills include noise, dust, air pollution, the release of toxic gases unless they are collected, the potential for groundwater contamination, and the potential for encouraging waste production. Leachate, or liquid that drains through the landfill, can also carry toxic substances and contaminants. Sanitary landfills also experience Not in My Backyard syndrome.
Waste management is an important subject on the APES exam because it deals with human interaction with the environment. You will see questions dealing with waste and waste management in all sections of the AP Environmental Science exam. Below, we will walk through a sample free response question from a previous exam.

The city of Fremont operates a municipal solid-waste landfill. As represented in the diagram above, the annual precipitation in Fremont is 200 mm/year: 50 percent of this water infiltrates through the landfill cover soil into the waste, and 50 percent drains off the landfill.
A drainage system withdraws 90 percent of the leachate generated within the landfill for treatment. The rest of the leachate travels through the bottom liner of the landfill into the surrounding soil. Most of the cadmium disposed of in the landfill remains in the landfill; the leachate withdrawn from the landfill by the drainage system has an average cadmium concentration of 2.0g/m$^3$. Pumped to a treatment station, the leachate is treated at a cost of $10/m^3$.

(a) Calculate the volume, in m$^3$, of each of the following:
(i) The water infiltrated through the landfill per year
(ii) The leachate that is treated per year

(b) Given that the cadmium concentration in the water draining from the landfill is 2.0g/m$^3$, calculate the mass, in kg, of cadmium that is released into the surrounding soil per year.

(c) What is the annual cost of treating the leachate from the drainage system?

(d) Discuss TWO viable methods for reducing the amount of cadmium entering the municipal waste input.

(e) Explain a shortcoming of ONE of the methods that you identified in part (d).

In part (a) of this question, you can earn two points for part (i) and two points for part (ii). One point is for correct setup and the other is for the correct answer. In part (i), the correct answer is 1000m$^3$. The proper set up to get this answer is listed below.

\[
2.00mm \times \frac{1m}{1000mm} = 0.2m
\]
\[
0.2m \times 10,000m^2 \times \frac{0.5}{1} = 1,000m^3
\]
In part (a)(ii), similar math is required. If you get the incorrect answer in part (i), you can still get points if your response in (ii) is 0.9 times that of your answer in part (i). Below is the correct math.

\[1,000m^3 \times 0.9 = 900m^3\]

Part (b) also requires some math and is worth two points. You can reach the correct answer here by completing the following math yielding the correct answer of 0.2kg Cd/year. It is important to remember to show your work here.

\[\frac{100m^3}{year} \times \frac{0.2gCd}{1m^3} \times \frac{1kg}{1,000gCd} = 0.2kgCd/year\]

In part (c) of this question, you can also earn two points, one is for correct setup and one is for the correct answer. You also must use your answer from part (a) (ii).

\[900m^3 \times \frac{$10}{1m^3} = $9,000/year\]

In part (d), you will need to discuss two potential ways to reduce the amount of cadmium in the landfill. Possible correct answers include reducing the use of products with cadmium in them, sorting waste and removing items that contain cadmium, and placing a surcharge or deposit on cadmium containing products.

In part (e), you need to discuss a challenge associated with one of the potential solutions you mentioned in part (d). For this example, we will use the fact that reducing the use of products with cadmium in them would be highly difficult and require contacting many companies and convincing them to change their products.
Waste Management: AP Environmental Science Crash Course Review Cont.

It is important to remember that there are many correct answers for parts (d) and (e). This is particularly helpful if you are having trouble remembering possible answers on the exam.

In this AP Environmental Science crash course review, we have defined waste, classified different types of waste, and described methods of waste reduction and management—everything you need to know about waste and waste management for the APES exam. By reviewing these comments and practicing applying them to specific examples as we have done here, you will be able to manage any waste APES exam can throw your way.
While studying for the AP Environmental Science exam, you have probably run across the subject of water pollution, but you might not have a thorough understanding of what water pollution is, why it is important for the APES exam, and how to answer questions about water pollution on the AP Environmental Science exam.
Water Pollution: AP Environmental Science Crash Course Review Cont.

In this AP Environmental Science crash course review, we will thoroughly explain water pollution, giving you everything you need to know for the AP Environmental Science exam.

What is Water Pollution?

First, you may be wondering what water pollution is. Water pollution is defined as any chemical, biological, or physical change in water quality that causes a harmful impact on living organisms. There are two different categories of water pollution. The first is pollutants that cause health problems and the second is pollutants that disrupt ecosystems.

Water pollution can be natural or it can be caused by humans. Natural sources of water pollution include sediment caused by erosion and naturally occurring oil seeps. Water pollution caused by humans includes infectious agents, wastes that require oxygen, inorganic chemicals, organic chemicals, plant nutrients, and heat.

Identifying, Regulating, and Cleaning Up Water Pollution

In order to effectively clean up water pollution, the source of pollution first needs to be identified. There are two different types of pollution sources: point and non point. Point sources release pollution from a specific identifiable location. Examples of point sources include power plants, factories, coal mines, or other locations. Point sources are relatively easy to identify, regulate, and monitor.

Non point locations have no specific point of origin. This makes them significantly more difficult to regulate and monitor. Examples of non point sources of pollution include runoff from fields, lawns, parking lots, and other areas. Precipitation such as snow may spread pollutants through the environment when melts. The single biggest source of ocean pollution is runoff from terrestrial sources.
Water Pollution: AP Environmental Science Crash Course Review Cont.

It is also important to note that non point sources of water pollution can also come from the air. Pollutants can be carried by air currents and then released through precipitation. Pollutants deposited in this manner can originate from thousands of kilometers away. This great distance obviously makes it impossible to regulate or monitor these pollutants.

**Groundwater Pollution**

Groundwater is a highly important source of drinking water in the US. Nearly 50% of people get their drinking water from an underground aquifer. It is commonly assumed that natural processes in aquifers clean any contaminated water, but overuse has stressed these reservoirs, which can result in groundwater pollution.

Fertilizers and pesticides are common pollutants of groundwater, particularly in farming communities. Nitrates from fertilizers commonly exceed safe levels in rural water supplies. The largest source of groundwater pollution is chemicals and wastes from agriculture. Residence time, the amount of time water stays in an aquifer, can be very long, meaning that some pollutants can be very stable underground. The high expense of pumping water out of an aquifer to clean it means that contaminated water does not always get cleaned.

**Sewage**

Sewage is a significant source of water pollution and can easily create health related problems as a result. Pathogenicity is the level of severity and virulence of illnesses that biological agents cause and varies by the biological agent. The EPA sets limits on the amount of common biological agents that can be present in water supplies. In the following sections we will discuss ways that water-borne diseases can be prevented.
Water Pollution: AP Environmental Science Crash Course Review Cont.

**Septic Systems**

While human and animal wastes are used in some cultures as a fertilizer for crops, they can also introduce disease causing pathogens into the food supply. As a result, septic systems were developed as a way to improve public health, particularly in rural areas. In a septic system, water drains into a septic tank. Solids sink to the bottom while oils and other lighter density items rise to the top. Solids decompose in the bottom. Extra liquid is then channeled out through drain pipes which are surrounded by gravel. Excess water then evaporates. Septic systems must be pumped occasionally and the effluent must be taken to a treatment plant.

**Municipal Sewage Treatment**

In a municipal sewage system, there are typically three levels, the first being primary treatment. In the primary treatment stage, raw sewage enters the treatment plant and large solids are separated from general waste. Screens remove large debris and small objects. Sand and gravel settle in one tank and the waste stream continues into a different tank where about half of the organic solids settle to the bottom and become sludge.

Next is the secondary treatment phase where dissolved organic compounds are biologically degraded. This process starts when the primary treatment phase material flows through an aeration tank, this is sometimes referred to as activated sludge process. A bacteria-rich slurry is mixed with the material from primary treatment. Air is then pumped into this mixture which encourages the bacteria to grow. The amount of air required is determined by the biological oxygen demand, defined as the amount of oxygen required by anaerobic organisms to decompose the organic matter in water. The bacteria then break down the organic matter. This results in sludge and water. If the sludge is not contaminated with heavy metals, it can be used as fertilizer. If it has been contaminated, it has to be disposed of properly at a large expense.
The third step of treating municipal solid waste removes plant nutrients, including nitrates and phosphates that are still in the waste from the second step of treatment.

Once treated, waste water is free of pathogens and organic matter, but may contain high levels of inorganic nutrients. If it is released into surface waters, this can cause algal blooms or eutrophication, the natural nutrient enrichment of a lake. This nutrient overload can lead to high growth of algae and other microorganisms.

Clean Water Legislation

The Clean Water Act, passed in 1972, was passed to return all surface waters in the United States to “fishable and swimmable” conditions. Clean water thus became a national priority. Specific point sources of pollution are required to acquire permits and develop technology to control their output in order to be in compliance with the Act. The Act also requires the best available and economically achievable technology for limiting the discharge of toxic substances and allows no discharge of 126 toxic pollutants.

Through the efforts of the Clean Water Act, conditions in surface water in the United States have dramatically improved. All water is not yet swimmable and fishable, but there have been significant improvements and significant allocation of federal and state monies to build municipal sewage treatment facilities.

The Safe Drinking Water Act regulates drinking water in municipal and commercial systems. It is criticized as having too loose of regulations in rural areas and allowing the presence of herbicides and pesticides in rural drinking water.

The Great Lakes Water Quality Agreement was signed between the US and Canada in 1972. This agreement focuses on cleaning up the Great Lakes and has made great strides in improving the water quality in the Great Lakes.
2. Like many communities, Fremont has a combined sewer system that collects both sewage and storm water. When storm water runs into storm drains that connect to the city’s sanitary sewer system, the storm water and sewage flow together to the Fremont Waste Water Treatment Plant (FWTP). During a major storm event, however, the combined volume of storm water and sewage may exceed the plant’s capacity, and the overflow bypasses the FWTP.
The untreated overflow is discharged into Fremont Creek along with the treated waste. Recently parts of Fremont received 5 cm of rain in 60 minutes. The storm caused widespread flooding in the northeast section of town. Especially hard hit was the Shoppes at Fremont shopping center. Use the data from the table below to answer the questions that follow. Show all calculations.

(a) Identify TWO specific pollutants in storm-water runoff that degrade the quality of surface water.
(b) Calculate the volume of water (in m$^3$) that runs off the Shoppes at Fremont parking lot after a 5 cm rainfall event. Assume that all the water that falls on the parking lot runs off.
(c) Calculate the volume of storm-water runoff (in m$^3$) generated in all of Fremont by the 5 cm rainfall event. Assume that only the impervious surfaces generate runoff.
(d) Assume that all the runoff that you calculated in part (c) is captured by the storm sewers in one day. Calculate the volume of untreated water (in m$^3$) that bypasses the plant as a result of the storm. (Note that the plant still receives 5,000 m$^3$ of domestic sewage per day.)
(e) Describe TWO ways that the volume of storm-water runoff can be reduced.
(f) Describe one environmental problem (other than pollution from runoff and from untreated sewage) that results from having extensive paved areas.

This free response question is worth ten points in total. In part (a), you can earn two points- one for each specific pollutant. Some correct answers to this part include nitrogen, phosphates, pesticides, herbicides, trash, and detergents.
In part (b) of this question, you can earn a total of two points. One is for setting up the math correctly and one is for arriving at the correct answer. In order to get credit for having the correct answer, you need to show your work. The image below shows a correct set up for this question as well as the correct answer.

\[200m \times 100m \times 0.05m = 1,000 m^3 \text{ or } 1 \times 10^3 m^3\]

In part (c) of this question, you can also earn two points. It is important to note that you are to assume that only impervious surfaces generate runoff. Because of this, you need to ensure that you multiply the area of Freemont by 0.20 to account for the percentage of Freemont that is composed of impervious surfaces. Your math should look something like this.

\[5cm \times \frac{1m}{100cm} \times 10km^2 \times \frac{1 \times 10^6 m^2}{1km^2} \times 0.20 = 100,000 m^3 \text{ or } 1 \times 10^5 m^3\]

In part (d) of this question, you can receive one point for showing your work and achieving the correct answer. In part (d), it is especially important to note that the plant still receives 5,000 m$^3$ of domestic sewage per day. If this amount is not accounted for in your math, your answer will be incorrect. Your work should look something like this, with the correct amount of water that bypasses the plant being 95,000 m$^3$.

\[100,000 m^3 + 5,000 m^3 - 10,000 m^3 = 95,000 m^3\]

In part (e) of this question, you can earn two points, one for each way to reduce the volume of storm water runoff. Some correct answers to this part include the installation of ponds or other basins to hold runoff water, installing rain barrels or other devices to store water, and decreasing the amount of impervious surfaces in Fremont.
In part (f) of this question, one point is available for correctly naming an environmental problem resulting from having extensive paved areas that is not related to untreated sewage or pollution from runoff. Some correct answers to this question include increased flooding, groundwater depletion, and habitat destruction.

In this AP Environmental Science crash course review, we have reviewed everything you need to know about water pollution for the APES exam and walked through a sample free response question about water pollution from a previous AP Environmental Science exam.
Ready to get a 5?

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Start Practicing
While reviewing for the AP Environmental Science Exam, you have probably come across the term renewable energy, but you might not have a complete understanding of what renewable energy is and why it is important for the APES exam. In this AP Environmental Science crash course review, we will review what renewable energy is, why it is important for the AP exam, and walk through a sample question from a previous exam.
Renewable Energy: AP Environmental Science Crash Course Review Cont.

What is Renewable Energy?

Renewable energy is energy that is generated from natural sources and is replenished by nature. Examples include sunlight, wind, rain, tides, and geothermal heat. Technologies that utilize renewable energy include solar power, wind power, hydroelectric plants, biomass, and biofuels. You may also hear renewable energy sources referred to as alternative energy sources. This simply means that they are alternatives to fossil fuels. Alternative energy is also generally considered to have a low environmental impact, which differentiates it from renewable energy as not all sources of renewable energy have low environmental impact.

Biomass and Biofuel

Biomass is renewable organic matter. It includes biological material derived from organisms that are either living or were recently living and includes wood, waste, and alcohol fuels. Alcohol fuels are almost exclusively derived from corn.

Biodiesel is fuel made from plant oils that can be used in diesel engines. It can be made of soybean and rapeseed oils, animal fat, and waste vegetable oils. Biodiesel is considered by some to be an ideal substitute for fossil fuels as it does not divert land previously used for food into growing corn for ethanol production and it is a renewable resource.

Hydroelectric Energy

Hydroelectric energy is generated by the force of water moving through a turbine. One distinct advantage of hydroelectric energy is that it does not release pollutants the same way other sources of energy do; however, hydroelectric energy does cause thermal pollution.
Renewable Energy: AP Environmental Science
Crash Course Review Cont.

Thermal pollution caused by water used to cool the turbines being returned local bodies of water at a higher temperature than it was when it came into the turbines. This change in temperature causes changes in the ecosystem.

There are several other problems with hydroelectric energy. One is the limited number of places it can be used due to the limited number of rivers with sufficient drop and flow to accommodate hydroelectric plants. Another problem is known as silting. Silting occurs as water sits behind the dam. Sediment sinks to the bottom and places pressure on the dam, meaning that dams must be built strong enough to withstand silting.

Additionally, since the reservoir usually has a greater surface area than the river did before hand, evaporation and water loss is usually higher than it was before. Fish populations, particularly fish that usually spawn in silty waters, also decline as a result of adding a hydroelectric plant because the plant limits the movement of fish in the river.

Solar Energy

Solar energy can also satisfy our external energy needs. Solar energy can be utilized through passive solar energy collection and active collection. Passive solar energy collection is the use of building materials, placement, and design to take advantage of solar energy for heating or cooling.

Active collection is the use of devices, such as solar panels and batteries, to collect, focus, transport, or store solar energy. Solar thermal panels absorb solar energy and pass the energy to tubes where water is circulating so that the heated water can be stored for future use. Photovoltaic cells absorb solar energy, creating electricity. Excess electricity can either be stored in batteries or sold to the grid.
Solar energy has advantages, namely the fact that it is low maintenance and quiet. Disadvantages include the fossil fuels needed to make solar equipment, the high cost, and lack of sufficient sun in some locations. Government programs in some states offer financial benefits to homeowners who install solar panels, which can help defray some of the high costs. New technology and innovations in solar panels will also help bring the costs of solar power down in the future.

**Wind Energy**

Wind energy is collected using windmills. The wind turns the blades, driving a shaft that is connected to several cogs. These cogs turn wheels that can be used to perform mechanical work, such as grinding corn or pumping water. Modern wind turbines look a lot like airplane propellers. The wind spins the blades and causes the machinery in the base of the windmill to rotate. The base is called the nacelle, which houses a gearbox, generator, and machinery needed to power the turbine. Wind turbines can be set up to use wind energy at all speeds, or only when the wind reaches a certain velocity.

Wind energy is the fastest growing alternative energy source as many locations have enough wind to utilize this technology. Wind turbines are usually placed in groups called wind farms. Wind farms can also be located offshore, but are currently only located near the shore.

Wind energy, like other forms of energy, has benefits and drawbacks. Benefits include the fact that there is sufficient wind in many locations for turbines and wind energy produces no emissions. Drawbacks to wind energy include the significant financial investment required to start harnessing wind power, aesthetic concerns, and the threat to birds. The most insurmountable of these drawbacks is the financial cost of wind power. Aesthetic concerns are a matter of opinion and turbines pose less of a risk to birds than other towers provided they are not located in migration routes.
Geothermal Energy

Geothermal energy is energy that is obtained from inside the earth and harnesses the earth’s internal heat. The naturally heated water and steam from the earth’s interior is utilized to turn turbines, creating electricity. Deep wells are usually utilized for this technology. Geothermal energy can also be used directly, such as when heated water is piped directly through buildings for heat. This is particularly common in Iceland.

Geothermal heat has its advantages, but it also has disadvantages. Advantages include the fact that this source of energy is renewable. Disadvantages include the limited number of areas where geothermal energy can be used, corrosion of machine parts due to salts in the water, the emission of some gasses that can be released when the water is used, and the limited amount of ground water if the water is not replaced.

Renewable Energy on the AP Environmental Science Exam

On the AP Environmental Science exam, you will likely see many questions about renewable and alternative energy sources, both in the multiple choice and free response sections of the exam. Below, we will walk through a free response question from a previous AP Environmental Science exam.
Read the article below and answer the questions that follow.

(a) Calculate the number of acres required to produce 1,000 gallons of oil in one year from
   (i) microalgae
   (ii) soybeans

(b) Describe TWO environmental advantages that biodiesel production from microalgae offers over biodiesel production from the other crops listed in the table.
(c) **Explain why burning biodiesel fuel has a different impact on atmospheric CO₂ concentrations than does burning fossil fuels.**

(d) **Discuss TWO benefits, other than those related to atmospheric impacts, of increased reliance on biodiesel fuels over the next 50 years.**

(e) **Describe TWO economic or societal problems associated with producing fuel from corn.**

In part (a) (i) of this question, one point is available for the correct number of acres needed to produce 1,000 gallons of oil in one year from microalgae. Looking at the table in part (a), you will see that microalgae produces 10,000 gallons of oil per acre. Multiplying this by 1,000 gallons yields the correct answer of 0.1 acres. Your answer should look something like the following.

\[
1\text{acre} = 10,000\text{gal}; \quad 1,000\text{gal} \times \frac{1\text{acre}}{10,000\text{gal}} = 0.1\text{acre}
\]

In part (a) (ii) of this question, one point is possible for giving the correct number of acres needed to produce 1,000 gallons of oil in one year from soybeans. You can calculate this number with the same type of multiplication you used in part (a) (ii) of this question. One acre of soybeans yields 50 gallons of oil as per the chart in the original question. Multiplying this number by 1,000 gallons yields the correct answer of 20 acres.

\[
1\text{acre} = 50\text{gal}; \quad 1,000\text{gal} \times \frac{1\text{acre}}{50\text{gal}} = 20\text{acres}
\]

In part (b) of this question, two points are available. One for each advantage of using microalgae to produce oil and its corresponding description. There are many possible correct answers here, giving you options if you are having trouble on the exam. Two correct advantages include decreased land use which allows for less habitat destruction and less nutrient depletion of the soil due to less land being used.
In part (c) of this question, one point is available for correctly explaining why biodiesel has a different impact on atmospheric CO$_2$ concentrations than burning traditional fossil fuels. The correct answer to this part is that biodiesel is composed of carbon that was recently in the atmosphere, meaning that biodiesel does not contribute to a net increase in the amount of carbon dioxide currently in the atmosphere.

In part (d) of this question, three points are available. To earn all three points, you need to list two correct benefits and two appropriate discussions of the benefits of increased reliance on biodiesel fuels over the next 50 years that are not focused on atmospheric impacts or speculation. There are many correct benefits and discussions that you could use here. Correct answers include decreased reliance on imported fossil fuels leading to greater self-sufficiency, increased jobs due to higher labor needs in the agricultural industry, and reduced transportation costs as biofuels would not need to be transported as far as fossil fuels. It is important to remember not to speculate here. While the high cost of fossil fuels in the future may seem certain to you, it still falls into the speculative category.

In part (e) of this question, two points are possible. To earn both, you need to name two economic or societal problems associated with producing fuel from corn and give correct corresponding descriptions of these problems. There are many correct answers to this question. Possible answers include increases in corn prices as corn is diverted to energy production, resulting in a greater demand for corn, increases in food prices because of increased demand for corn and increased corn prices, and decreased availability of land for nonagricultural use due to increased demand for agricultural land as a result of growing corn for fuel. There are many correct answers here and you are only limited by what you can come up with.
Wrapping Up Renewable Energy and AP Environmental Science

In this AP Environmental Science crash course review, we have covered the major renewable energy sources, what you need to know about them, and walked through a sample free response question on renewable energy, giving you everything you need to know about renewable energy for the APES exam.
A comprehensive understanding of energy is crucial to succeeding on the AP Environmental Science exam. On the APES exam, you will encounter problems that will require you to solve problems related to solar energy, fossil fuels, power plant operation, and other energy concepts. In this crash course review, we’ll cover what you need to know about energy and a sample free response question involving energy calculations. Let’s get started.
Energy Calculations: AP Environmental Science
Crash Course Review Cont.

What is Energy?

Energy is the ability to do work. Energy cannot be created, it must come from somewhere, this is the first law of thermodynamics. Energy can be transferred to different forms, but some of it becomes unusable at each step in the process, this is the second law of thermodynamics. Energy comes in many forms, kinetic, potential, mechanical, etc., but all forms of energy have the ability to do work.

Measuring Energy

In physics, work is defined as force times the distance through which the force acts. From this definition, we get the idea that energy is the property that allows one to move objects and thus accomplish some physical labor or work. Thus, all forms of energy must be reducible to these units.

There are two systems of measurement: The United States Customary System used in the US and the metric system (SI) which is used everywhere else. The metric system is used in science and a specific subset of the system centimeter-gram-second, is particularly relevant for the APES exam. The following table exhibits how force and energy are measured in the major measurement systems.

<table>
<thead>
<tr>
<th>System</th>
<th>Force</th>
<th>Mass x</th>
<th>Acceleration</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI (mks)</td>
<td>Newton</td>
<td>Kilogram</td>
<td>m/s²</td>
</tr>
<tr>
<td>SI (cgs)</td>
<td>Dyne</td>
<td>Gram</td>
<td>Cm/s²</td>
</tr>
<tr>
<td>USCS (fps)</td>
<td>Lb</td>
<td>slug</td>
<td>Ft/s²</td>
</tr>
</tbody>
</table>
Energy Calculations: AP Environmental Science
Crash Course Review Cont.

### Units in Energy Calculations

In order to effectively calculate energy on the APES exam, there are several specialized units that you will need to know. We will break down these units and how they are used below.

#### The Newton

The newton is named after Isaac Newton and is a unit of force. It is capitalized when it is abbreviated, but not when used in measurement (e.g. N). In the above table, it can be seen that one newton is equal to $1\text{kg} \times 1\text{m/s}^2$, about 0.225lbs. It is a common mistake to think one newton equals one kilogram, but it is important to note that that is not the case.

#### The Joule

The joule (J), named for Sir James Prescott Joule, a British energy scientist, is an energy unit and is defined as the work completed by the force of one newton acting at a one-meter distance. One joule is very small, but it remains the unit of energy most often used in science.

<table>
<thead>
<tr>
<th>System</th>
<th>Energy</th>
<th>Force</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI (mks)</td>
<td>Joule</td>
<td>Newton</td>
<td>Meter</td>
</tr>
<tr>
<td>SI (cgs)</td>
<td>Erg</td>
<td>Dyne</td>
<td>Centimeter</td>
</tr>
<tr>
<td>USCS (fps)</td>
<td>Ft-lb</td>
<td>Lb</td>
<td>Foot</td>
</tr>
</tbody>
</table>
The Calorie

The calorie was also discovered by Sir James Prescott Joule and is the heat needed to raise one gram of water one degree Celsius. His discovery of the calorie demonstrated that mechanical energy and heat are equivalent. There is also the kilocalorie or Calorie (note the capital c). A kilocalorie will raise one kilogram of water by one degree. Calories in food are always kilocalories.

\[ 1\text{calorie} = 4.184\text{joules} \]

The calorie can be used to determine a fuel’s energy content. The fuel is burned to exhaustion, the heat is transferred, and the temperature difference is measured, allowing the ability to calculate, in calories, the energy content of the fuel which can then be converted to Joules.

The Btu

The Btu is a common unit for heat energy that you will see on the AP Environmental Science exam. One BTU is the amount of heat required to raise a pound of water by one degree Fahrenheit.

\[ \text{Using } \frac{\text{2.2lbs}}{\text{1kg}} \text{ and } \frac{1.8\text{degree fahrenheit}}{1\text{degree celsius}}, \text{it can be found that:} \]

\[ 1\text{BTU} = 252\text{calories} = 1055\text{joules} \]

The Therm

Another unit of measure you will encounter both on the AP Environmental Science exam is the therm or thermal unit, which is used by gas companies to measure how much natural gas you use. 1 therm = 100,000 BTU. One cubic foot of natural gas has a heat value of 1030BTU$^3$ at normal temperature and pressure, meaning that one therm is approximately equal to 100 cubic feet of natural gas.
Energy Calculations: AP Environmental Science Crash Course Review Cont.

Gas companies also use different terminology where c stands for 100 and where m stands for 1000. They are used as numerical prefixes and are not capitalized due to the potential for confusion with SI units.

**Power**

Power, the term that describes energy flow, is defined as the time rate of work and is measured in joules per second. One Watt is equal to one joule per second. There is no unit to measure power in the cjs system. In USCS system, horsepower is the unit used for power and one horsepower equals 550 ft-lbs per second, equivalent to 0.75 kW or 746 watts.

It is easy to confuse power and energy when in dealing with watts. A useful analogy for thinking about this is to think about buying gas. You pay based on the amount of gas you put in your car, not how fast you put the gas in your car.

When you pay your electric bill, the electricity you use will be measured in kilowatt hours or kWh. One kilowatt will power ten 100-watt light bulbs for one hour. Kilowatt hours can easily be converted to joules as seen below. This is the energy you are paying for on an electric bill.

\[
1\text{ kWh} = 1,000\text{j/s} \times 3,600\text{s} = 3.6 \times 10^6\text{J}
\]

**Electric Power Plants**

You will also likely see questions about electric power plants on the AP Environmental Science exam. Electric power plants are rated based on their output capacity. For example, a large electric power plant may be rated at 1,000 MWe where the e is electric and reminds you that this signals the output of the plant as opposed to the input. Input is measured in terms of the heating value of the fuel that the power plant uses.
If you know the output capacity of a power plant and the level of efficiency, you can calculate the amount of fuel needed to power the plant or the energy input. For example, with an efficiency rating of 40% the calculations would be as follows:

\[
\frac{1,000\, MW}{0.40} = 2,500\, MW
\]

\[
\frac{2,500\times10^6\, \text{j/s} \times 3,600\, \text{s/h}}{1,054\, \text{j/btu}} = 8.54 \times 10^9\, \text{btu/hr}
\]

To calculate tons of fuel needed per hour, you would divide the above number by the heating value of the fuel that power plant uses. You will see problems similar to this on the AP Environmental Science exam.

**Solar Energy**

Another energy calculation that you will run into on the APES exam is solar energy. The rate at which sun is received on the surface is called solar flux. At the earth’s orbit, this value is the solar constant 1,400W/m\(^2\). The atmosphere absorbs about half this amount, leaving 700W/m\(^2\). Averaging for day and night, seasons, and all latitudes, this number is further reduced to 240W/m\(^2\), but this amount varies some by location. Greenland, for example, gets less solar flux, than Brazil.

Solar energy is especially important in AP Environmental Science because it is a renewable energy source. Unlike fossil fuels, solar energy will be around for years to come. Additionally, solar energy is also important for calculations such as how much biomass will grow in one area compared to another.

**Energy Calculations on the AP Environmental Science Exam**

You will encounter questions about energy calculations on the AP Environmental Science exam in both the multiple choice and free response sections of the exam.
Energy Calculations: AP Environmental Science
Crash Course Review Cont.

In the multiple choice section, questions will typically require less math and be simpler to perform. In the free response section of the exam, you will need to make more involved calculations and show your work in order to receive credit. To help you prepare for the free response section of the exam, we will cover an energy calculation question from a previous exam.

Battery electric vehicles (BEVs) have been introduced to consumers as an alternative way to reduce the environmental effects caused by use of internal-combustion engine (ICE) vehicles. A comparison of both vehicle types can help determine whether the use of BEVs would be beneficial in the future. Where calculations are required, show your work.

(a) Identify THREE strategies that the federal government could implement to encourage the use of BEVs.

(b) Assume that the fuel efficiency of the ICE vehicle is 25 miles per gallon (mpg) and that gasoline costs $3.75 per gallon (gal). Calculate the cost of gasoline per mile.

(c) The charger supplies energy to the BEV battery at an average rate of 4.0 kilowatts (kW) and fully charges the BEV battery in 7.0 hours. The car will run for 100 miles on a full charge. The cost of electricity is $0.11 per kilowatt-hour (kWh).
   i. Calculate the cost of the electricity to fully charge the battery.
      Assume that the battery is not charged to begin with.
   ii. Calculate the cost of electricity per mile to drive the BEV.

When it is driven 100 miles, the ICE vehicle contributes 72.8 pounds (lb) of CO₂ from the burning of the gasoline. The drilling, refining, and transportation costs of getting the gasoline to the gas station add an additional 17.7 lb of CO₂ per 100 miles.
The BEV does not emit any CO\textsubscript{2} itself, but the extraction, transportation, and combustion of the coal that produced the electricity at the power plant add 63.6 lb of CO\textsubscript{2} for the same 100 miles.

(d) Calculate the difference in the amount of CO\textsubscript{2} that would enter the atmosphere if both cars were driven 100 miles.

(e) Describe TWO economic impacts (excluding costs related to climate change resulting from CO\textsubscript{2} emissions or the cost of gasoline at the pump) that result from an increased number of BEVs on the road.

As you can see, this question deals with power, and the kilowatt hour unit we discussed above. Part (a) of this question is worth three points, one for each strategy that could be implemented. This part does not require calculations and has many possible answers. You might cite increasing taxes on diesel and gasoline, creating restrictions for ICE vehicles, increasing the accessibility of charging stations, creating tax incentives for purchasing BEVs, or other possible incentives.

In part (b) of this question, two points are available and energy calculations are required. The first point is for setting your work up correctly and including units, the second is for getting the right answer. Your work should look something like this:

\[
\frac{\$3.75}{25\text{miles}} = \$0.15\text{permile}
\]

In part (c)(i), two points are available and energy calculations are required. One point is for setting your work up correctly including units and the second is for getting the right answer. Your answer should look like something like this:

\[
7\text{hours} \times 4\text{kwh} \times \frac{1\text{cents}}{\text{kwh}} = \$3.08
\]
In part (c)(ii), one point can be earned for the correct answer and work is not required, but it is still good practice to include your work. Your answer should look like this.

\[
\frac{\$3.08}{100} = \$0.03/\text{permile}
\]

Part (d) of this question requires some basic addition and is worth one point with work shown. Your answer should look something like this.

\[
72.8\text{lb} + 17.7\text{lb} = 90.5\text{lb}
\]
\[
90.5\text{lb} - 63.6\text{lb} = 26.9\text{lb}
\]

In part (e) of this question, you can earn two points, one for each correct impact. Possible correct answers include the fact that BEV drivers will save money that can be spent elsewhere, increased jobs in the electrical industry, and increased jobs and profit for manufacturing and repairing BEVs.

**Wrapping Up Energy Calculations**

This AP Environmental Science reviewed all the energy calculations and units you will need to know to be successful on the APES exam. By carefully reviewing these units and calculations, you will be able to apply them to any energy question you encounter on the APES exam.
The Ultimate List of AP Environmental Science Tips

If you’re preparing for the AP Environmental Science exam, you’re probably shooting for a score of 4 or 5. But how can you give yourself the best chances at a great score? There are so many study tips out there that it can seem overwhelming. Luckily, this list of AP Environmental Science tips is here to help you sort through the confusion and come up with a study plan that works.

Interested in an Albert license? E-mail us at schools@albert.io
First, you need to be aware that the exam is difficult. Are you ready for a scary statistic? Only 7.5% of all AP Environmental Science test takers earned a 5 on the 2015 exam. On this particular exam, students had the most difficulty with the free response questions, so it’s worth noting that low FRQ responses have the power to prevent you from getting a 5. On the same exam, 24.1% of students received a 4, 15.2% earned a 3, 25.5% scored a 2, and 27.7% got a 1. This means that over half of all test takers only earned a 1 or a 2!

Do not fret, though! Even if the statistics seem intimidating, you have the power to be in the top 30%, earning a score of 4 or 5, if you commit to doing it! It will take hard work, effort, confidence, and time, but nothing worthwhile in life is ever easy. Are you committed? Are you ready to embark on this AP journey? If yes, then you’re about to see the ultimate list of 45 AP Environmental Science tips. Let’s go!

**Overall How To Study for AP Environmental Science Tips**

1. **Understand the structure of the exam.** The most important thing to know before you start studying for the AP Environmental Science exam is what the exam is made up of. The exam is three hours long and consists of two sections:

   - **Section I: Multiple-Choice**
     - 90 minutes
     - 100 questions
   - **Section II: Free-Response**
     - 90 minutes
     - 4 questions

   It’s also worth noting that the multiple-choice section is worth 60% of your score, while the free-response section is worth 40%.
2. Buy a review book! More than likely, you’ve been given an environmental science textbook as part of your AP class. While textbooks are a great way to learn information, they are simply not enough. Textbooks give details, specifics, and an in depth view of environmental science, while review books focus on the topics you need to know for the exam. Review books also come with sample questions, diagnostic tests, overviews of essential topics, and other strategies for taking the exam. There are tons of review books out there, so choosing one may not be easy. However, you can’t go wrong if you give the Princeton Review, REA’s Crash Course, or Barron’s a try.

3. Watch the news daily. Did you know that you should add anecdotes and current event examples in your free-response answers? You will always need supporting evidence for your responses on the exam. Sometimes, learning only from the textbook or a review book won’t give you adequate examples to use on the exam. That’s where the news comes in. If you watch the news daily, or read about current events involving the environment, you are building up an arsenal of potential examples to use in your FRQs. Even better, supplementing your learning with current events will help you remember certain topics and key concepts, without having to rely on rote memorization.

4. Check out TED Talks. Along the same lines as watching the news, TED Talks are an excellent way to digest information. If there’s a topic you’re struggling with, a topic you find boring, or a topic you want to know more about, try watching a TED Talk about it. TED Talks have a way of making you feel excited about something you may have been uninterested in before. There are a wide variety of environmental TED Talks, ranging from pollution to food waste, and from biodiversity to natural resources.

5. Focus on pollution. When in doubt, study pollution. According to the CollegeBoard, 25% to 35% of all multiple-choice questions are related to pollution (impact on the environment, economic impact, pollution types, sustainability, etc.)
All other topics comprise between 10% to 15% of multiple-choice questions, so it’s clear that pollution is very important to know about for the exam. Spend some extra time studying pollution and make sure you have an expansive knowledge of it.

6. Make flashcards. There’s a reason flashcards are a common study technique—they work! For an exam that focuses so much on vocabulary words, flashcards are essential. To make effective flashcards, hand write the term and draw a picture or diagram relating to it on the front side, and put the definition, significance, and how/why/when the term is used on the backside. It’s not enough to simply put the term and its definition. You have to make sure you understand how the term connects to other terms and what it means in context. For a good, comprehensive list of words you need to know for the APES exam, use this review sheet. It would be beneficial to make flashcards on each one of these terms.

7. Watch review videos. It’s worth it to search out videos on topics you’re studying. YouTube is not the only source for videos, either. HippoCampus has a great collection of short review videos on key topics from institutions like NASA and National Geographic. It also has simulations you can interact with on topics like solar radiation, gas properties, the greenhouse effect, and more. Since reading can get boring, watching informational videos or interacting with simulations can help break up the monotony and keep you motivated.

8. Follow environmental science social media accounts. A good way to incorporate environmental topics into your everyday life is through social media. You probably spend a good chunk of your day scrolling through Facebook or Twitter, so why not inject some studying into that time? Like National Geographic on Facebook, follow Guardian Environment on Twitter, or follow environmental science boards on Pinterest. Whatever social media you prefer, you can find useful information to connect with.
9. **Study infographics.** What happens when you get tired of your textbook, review books, and videos? Try infographics! Infographics, a hybrid of information and graphics, tell stories, explain important topics, and display statistics in visually appealing ways. While statistics and specific numbers aren’t too important for the APES exam, infographics can help give you a clearer picture of certain ideas. Next time you need to take a break from flashcards or reading textbooks, check out some infographics like *The Real Impact of Environmental Disasters*, *Deforestation: Our Disappearing Woodlands*, and *The Global Water Crisis: The Invisible Threat to Humanity’s Future*.

10. **Check out environmental science Apps.** Studying for the AP Environmental exam is all about finding different resources to keep you interested. What better way to fight off boredom than through Apps? The best environmental Apps are not free, but $0.99 can get you a lot! Try downloading *Environmental Science Buddy*, which includes lessons, quizzes, videos, and up-to-date current event information. The *APES Crash Course* is also an excellent App to use for reviewing information specific to the AP Environmental Science exam.

   **Start your AP Environmental Science Prep today**

**AP Environmental Science Multiple-Choice Tips**

1. **Focus on specific themes.** The AP Environmental Science exam follows a pattern when it comes to multiple-choice questions. Instead of just a random selection of questions across topics, the exam adheres to a percentage of questions for each theme of the course. It’s helpful to know these so you can plan your studying accordingly.
AP Environmental Science Multiple-Choice Tips

1. **Focus on specific themes.** The AP Environmental Science exam follows a pattern when it comes to multiple-choice questions. Instead of just a random selection of questions across topics, the exam adheres to a percentage of questions for each theme of the course. It’s helpful to know these so you can plan your studying accordingly.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Percentage of Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth Systems and Resources</td>
<td>10%–15%</td>
</tr>
<tr>
<td>The Living World</td>
<td>10%–15%</td>
</tr>
<tr>
<td>Population</td>
<td>10%–15%</td>
</tr>
<tr>
<td>Land and Water Use</td>
<td>10%–15%</td>
</tr>
<tr>
<td>Energy Resources and Consumption</td>
<td>10%–15%</td>
</tr>
<tr>
<td>Pollution</td>
<td>25%–30%</td>
</tr>
<tr>
<td>Global Change</td>
<td>10%–15%</td>
</tr>
</tbody>
</table>

As you can see, pollution is the most covered topic on the multiple-choice sections, with all other topics having generally the same amount of coverage.

2. **Familiarize yourself with the types of multiple-choice questions.** On the APES exam, you will see a variety of different types of multiple-choice questions. The table below details the question types you’ll see and an example question. Familiarize yourself with these questions so you’re prepared come exam time.
### The Ultimate List of AP Environmental Science Tips Cont.

<table>
<thead>
<tr>
<th>Type of Question</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definitional</strong></td>
<td>Any factor that influences a natural process under study is a(n)</td>
</tr>
<tr>
<td></td>
<td>(A) Independent variable</td>
</tr>
<tr>
<td></td>
<td>(B) Dependent variable</td>
</tr>
<tr>
<td></td>
<td>(C) Control</td>
</tr>
<tr>
<td></td>
<td>(D) Placebo</td>
</tr>
<tr>
<td></td>
<td>(E) Experimental value</td>
</tr>
<tr>
<td><strong>Cause And Effect</strong></td>
<td>_______ contributes to the formation of _______ and thereby compounds the problem of _______.</td>
</tr>
<tr>
<td></td>
<td>(A) Ozone, carbon dioxide, acid rain</td>
</tr>
<tr>
<td></td>
<td>(B) Carbon dioxide, carbon monoxide, ozone depletion</td>
</tr>
<tr>
<td></td>
<td>(C) Sulfur dioxide, acid deposition, global warming</td>
</tr>
<tr>
<td></td>
<td>(D) Nitrous oxide, ozone, industrial smog</td>
</tr>
<tr>
<td></td>
<td>(E) Nitric oxide, ozone, photochemical smog</td>
</tr>
<tr>
<td><strong>Sequencing</strong></td>
<td>Which of the answers below correctly describes the order in which environmental legislation would pass through Congress?</td>
</tr>
<tr>
<td></td>
<td>I. Reports the bill out of the appropriate committee</td>
</tr>
<tr>
<td></td>
<td>II. Debates the bill on the floor of the respective houses</td>
</tr>
<tr>
<td></td>
<td>III. Rejects or accepts amendments to the bill</td>
</tr>
<tr>
<td></td>
<td>IV. Resolves any differences in a conference committee</td>
</tr>
<tr>
<td></td>
<td>(A) I, II, III, IV</td>
</tr>
<tr>
<td></td>
<td>(B) I, III, IV, II</td>
</tr>
<tr>
<td></td>
<td>(C) II, IV, I, III</td>
</tr>
<tr>
<td></td>
<td>(D) III, I, II, IV</td>
</tr>
<tr>
<td></td>
<td>(E) IV, III, II, I</td>
</tr>
</tbody>
</table>
### The Ultimate List of AP Environmental Science Tips Cont.

<table>
<thead>
<tr>
<th>Type of Question</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generalization</strong></td>
<td>What is generally considered to be the most significant factor in terms of being a causative agent for cancer?</td>
</tr>
</tbody>
</table>
| | (A) Smoking  
| | (B) Diet  
| | (C) Stress  
| | (D) Heredity  
| | (E) Pollution |
| **Solution** | 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 |
| **Hypothetical Situations** | Converting to a solar-hydrogen energy source could theoretically be achieve by |
| | (A) attracting private investors  
| | (B) passing legislation that would fund “seed money” for entrepreneurs  
| | (C) passing legislation that would discontinue government subsidies of fossil fuels  
| | (D) education the public as to the environmental benefits of solar-hydrogen fuel source  
| | (E) all of the above |
### The Ultimate List of AP Environmental Science Tips Cont.

<table>
<thead>
<tr>
<th>Type of Question</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparing/Contrasting</td>
<td>Compared with more developed countries, which of the following statements is true of less developed countries?</td>
</tr>
<tr>
<td></td>
<td>(A) A higher percent of the labor force is engaged in food production.</td>
</tr>
<tr>
<td></td>
<td>(B) The population pyramids exhibit narrower bases.</td>
</tr>
<tr>
<td></td>
<td>(C) The per capita consumption of energy is higher.</td>
</tr>
<tr>
<td></td>
<td>(D) The natural increase of the population is lower.</td>
</tr>
<tr>
<td></td>
<td>(E) Fertility rates are lower.</td>
</tr>
<tr>
<td>Multiple Correct Answers</td>
<td>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?</td>
</tr>
<tr>
<td></td>
<td>I. The exotic species is resistant to pesticides.</td>
</tr>
<tr>
<td></td>
<td>II. There is a large, underutilized food source in the new environment.</td>
</tr>
<tr>
<td></td>
<td>III. The exotic species has few natural predators in the new environment.</td>
</tr>
<tr>
<td></td>
<td>(A) I only</td>
</tr>
<tr>
<td></td>
<td>(B) II only</td>
</tr>
<tr>
<td></td>
<td>(C) I and III only</td>
</tr>
<tr>
<td></td>
<td>(D) II and III only</td>
</tr>
<tr>
<td></td>
<td>(E) I, II, and III</td>
</tr>
</tbody>
</table>
The Ultimate List of AP Environmental Science Tips Cont.

<table>
<thead>
<tr>
<th>Type of Question</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>Which of the following is LEAST likely to be an effect of global warming?</td>
</tr>
<tr>
<td></td>
<td>(A) Loss of fertile delta regions for agriculture</td>
</tr>
<tr>
<td></td>
<td>(B) Change in global patterns of precipitation</td>
</tr>
<tr>
<td></td>
<td>(C) Extinction of some species that have narrow temperature requirements</td>
</tr>
<tr>
<td></td>
<td>(D) Decreased rate of photosynthesis in vegetation</td>
</tr>
<tr>
<td></td>
<td>(E) Increased frequency of hurricanes</td>
</tr>
<tr>
<td>Graph/Chart/Sketch</td>
<td>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?</td>
</tr>
</tbody>
</table>

Sources: CollegeBoard’s AP Environmental Science Course Description, Barron’s AP Environmental Science

For more practice multiple-choice questions like these, visit Albert.io.

3. Answer every single question. There is no penalty for wrong answers on the APES exam! This means you should answer each question, no matter what. If you find yourself running out of time, quickly look over your exam to make sure you’ve answered everything. If not, be sure to bubble in an answer, even if it’s just a guess!

4. Practice, practice, practice. The key to really doing well on the AP Environmental Science exam is practice. There are lots of resources that include practice multiple-choice questions. Take advantage of them! Many review books come with full-length multiple-choice sections you can take, complete with detailed explanations of the answers.
The Ultimate List of AP Environmental Science Tips Cont.

You can also check out Albert.io for tons of sample multiple-choice questions from all topics of the exam. There’s a reason “practice makes perfect” is a common phrase!

5. Stick to the course outline. The CollegeBoard has a list of the topics covered in the APES exam, which they call the Topic Outline. This is a great resource to use if you have no idea what to study, because it tells you the general topics you absolutely must know. For example, on the topic of Pollution, the exam will cover: pollution types, impacts of the environment and human health, and economic impacts. When in doubt, look at the Topic Outline.

6. Be aware of time. Since you’re given 90 minutes to answer 100 questions on the APES exam, you should spend an average of less than a minute on each multiple-choice question.

Start your AP Environmental Science Prep today

AP Environmental Science Free Response Tips

1. Know the types of free response questions. The free response section of the AP Environmental Science exam contains four questions of three different types:
   - 1 Document-Based question
   - 1 Data Set Analysis question
   - 2 Synthesis and Evaluation questions

   It’s also worth noting that each question is graded on a 10-point scale.

2. Know how to make a graph. If a free-response question asks you to make a graph, there are a few key things you should do to get full credit for your answer. A 2008 APES FRQ asked test takers to create a graph of data based on a given table of information.
The question provided students with the axes. Now, to answer this type of question, you should immediately label the x- and y-axis. Then, determine if you’re going to make a bar graph or a line graph. A good rule of thumb is if the information contains two sets of number, make a line graph, and if the information includes one set of numbers and one set of words, make a bar graph. There are times when either one can work. You then need to come up with a consistent scale for your graph, plot a smooth curve, make sure your data points aren’t misaligned, and title the graph.

3. Know how to answer a “describe” question. A 2012 AP Environmental Science FRQ asked students to “Describe TWO characteristics that are used by scientists to define an area as a wetland.” In questions that include the keyword “describe,” you need to define the topic and elaborate, using specific examples. For this particular question, two points were awarded: one for each characteristic, and nothing more. Only the first two responses were graded. A correct response would look like this:

“An area is a wetland if the soil is annually saturated with water. Moreover, wetlands contain plants and vegetation with adaptations that allow them to live under these conditions. If the area meets both of these characteristics, scientists define the area as a wetland.”

This response, which would receive full credit, is specific, gets to the point, and answers the question fully.

4. Include all the parts in a lab design question. Some FRQs will include a laboratory design question. In 2012, the AP Environmental Science exam included a lab design question about whether pesticides were toxic to minnows. In this type of question, you need to design an experiment that could actually be conducted.
The Ultimate List of AP Environmental Science Tips Cont.

To earn full points for lab design questions, you need to include four key components:

**Hypothesis:** Make sure your hypothesis is testable and doesn’t include phrases like “I think...” When in doubt, use “if, then” format, although this is not required. In the case of the pesticides and minnows, you would need to predict a relationship between the two, making sure you’re being as specific as possible. A correct response would be:

“Higher concentrations of the new pesticides will result in higher mortalities in a given population of minnows.”

**Methods to test hypothesis:** You need to be as specific and detailed as possible when coming up with methods to test your hypothesis. Act as if you are designing an experiment that you could do right now if you had the supplies. In the case of the minnows and pesticide, an example method would be:

“Four separate freshwater tanks will each contain 20 minnows. Tank 1 is the control and contains no pesticide. Tank 2 will have a .05% concentration of pesticide, Tank 3 will have a .1% concentration of pesticide and Tank 4 will have a .2% concentration of pesticide. After each day of exposure, the number of dead minnows will be counted and recorded. Exposure should last for 30 days.”

As you can see, this student included specific details (amount of pesticide concentration), a procedure that can be followed, an adequate amount of experimental groups, and a measured duration for the experiment.

**Control:** State exactly what the control is in your experiment. You can simply state it in your method as the student did above (“Tank 1 is the control and contains no pesticide”), or add it as a separate part to your response.
The Ultimate List of AP Environmental Science Tips Cont.

Dependent variable: Explicitly state the dependent variable in your response. Something simple like “The dependent variable is the number of dead minnows,” will get you full points.

5. **Show all of your steps in mathematical problems.** If a FRQ asks you to “calculate” something, you know that it’s a math-based problem. You may be given a graph or a table of information to base your answer off of. Pay attention to the formulas and data given to you, and be sure to use it. For these types of questions, you need to correctly set up the calculation (1 point) and arrive at a correct answer (1 point). The steps to getting your answer are just as important as the answer; so make sure you show all of your steps, even if you think they’re implied. Use scientific notation if possible, units, and write your final answer with a label.

6. **Solve each part of the question.** It may seem obvious, but make sure you solve every part of the question! Almost every APES free-response questions is divided into several different parts such as a, b, c, and d, often with i, ii, iii, etc. Don’t forget to answer each part. Even if you answer part (a) incorrectly, you can still receive credit for a correct answer to part (b).

7. **Avoid vague phrases.** Certain terms, such as the ones listed below, may sound specific to you as you’re writing them, but they usually carry no meaning and are very ambiguous. Avoid these phrases when writing your FRQs:

- “bad for the environment”
- “cause environmental degradation”
- “greener”
- “human impact”
- “harm the environment”
- “save the planet”
- “stop global warming”
- “ecofriendly”
The Ultimate List of AP Environmental Science Tips Cont.

- “global solution”
- “mother nature”
- “harmful chemicals” (without being specific)
- “human footprint”
- “sustainable” (without additional details)
- “make it illegal”

As an example, say you wrote, “Acid deposition hurts forests” as your answer. This provides no examples and the word “hurts forests” is too vague. How does it hurt forests? A better response would be, “Acid deposition can hurt forests in several ways. One way is by reducing the topsoil’s ability to retain vital nutrients such as calcium, magnesium and potassium which are needed by trees.” This response includes specific details and is the kind of response you should shoot for. Thanks to Mr. R. from Shaker High School for the list and example.

8. Think about the 3 E’s. Environment, ecological, or economic? Determine what the question is asking about. Responses to environmental or ecological questions should include plants, animals, and ecosystems – not humans. Responses to economic questions should involve money, costs, etc.

9. Brush up on simple algebra. You cannot use a calculator on the APES exam and although the exam isn’t AP Calculus, you still need to be familiar and comfortable with certain math concepts, such as dealing with percentages, rounding, fractions, and scientific notation. This APES math study sheet shows how to answer past FRQ data-analysis questions.

10. Explain technical terms. You can’t get away with simply dropping in vocabulary words without explaining them. You have to show that you have a complete understanding of the terms you use in your responses. For example, you can’t just write: “bioaccumulation increases the likelihood of biomagnification.” What do these words mean? Have you included specific examples?
The Ultimate List of AP Environmental Science Tips Cont.

11. **Focus on the how and why of environmental processes.** While it may be beneficial to know quantities and measurements, the AP readers don’t expect you to know them. Instead, make sure you know how environmental processes happen, why they happen, and the significance of them. Make sure you know specific examples of environmental processes.

12. **Write practice FRQs.** Practicing is absolutely essential for a great score on the AP Environmental Science exam. Seeing how questions are written, reading real responses from past test takers, and looking through scoring guidelines and rubrics will help you tremendously. Write practice FRQs as often as you can and have your classmates or teacher objectively grade them. Have your teacher help you pinpoint your strengths and weaknesses and how you can improve. The [CollegeBoard website](https://apcentral.collegeboard.org) has past APES free-response questions from 2003 to 2015, including scoring commentaries, statistics, and sample responses. Look at which response get high scores and which get low scores. Determine what makes a response a good response and why.

13. **Organize and label your responses clearly.** Since APES free-response questions usually have so many parts, organization is essential to having a great response. You have to remember that real people will be reading and grading your response, so make sure your answer is neat and easy to follow. Label your answers according to the part you’re answering, such as (a), (b), (c), etc. This not only helps the graders, but also helps you keep track of your responses and make sure you’re not missing anything.

14. **Answer in complete sentences.** You will not receive credit if you respond with bulleted lists or 1-word answers. You also shouldn’t draw a diagram as your response unless the question explicitly states that you should. Always write in complete sentences.

Start your AP Environmental Science Prep today
Tips by AP Environmental Science Teachers

1. **If a fourth grader could say it, it is too vague.** When you’re writing your free-response answers, include specific examples to keep your response from becoming too vague. Name specific chemicals, name specific species, name specific laws, etc. Eliminate “flowery” terms and phrases. Thanks for the tip from Mr. R. at Shaker High School!

2. **Rewrite the notes from class/text.** After class, rewrite or type-up your notes. Underline vocabulary words and new concepts. Annotate your notes with definitions for these terms. Make flashcards based on your notes from class. Thanks to Mrs. K. from Savannah Arts Academy for the tip!

3. **Watch “Home” by Yann Arthus-Bertrand from the GoodPlanetFoundation on YouTube.** This video covers many topics you need to know for the AP Environmental Science exam. Thanks to Ms. R. at Tallwood High School for the tip!

4. **Appreciate the outdoors.** To help understand the importance of taking AP Environmental Science, spend two or more hours camping, hiking, canoeing/kayaking, visiting a state or national park, or volunteering for an environmental group or learning center. Take pictures of nature and write about your experience. Thanks to Ms. Melanie L. at Perry High School for the tip!

5. **Read The Crash Course: The Unsustainable Future Of Our Economy, Energy, And Environment.** This eye-opening book covers topics like food supply, population, and energy and puts things into perspective. If you’re struggling to make connections between the economy, energy, and the environment, this book is for you! Thanks to Mr. Nick H. at Easton Area High School for the tip!

6. **Checkout the 70 Years of Environmental Change Timeline.** Thanks to Dr. E. from La Canada High School for the tip!
The Ultimate List of AP Environmental Science Tips Cont.

7. Do not be fragmentary in your explanations. Everything should fit together logically into a complete answer. Make sure you tie all the “pieces” of your answer together. Thanks to Dr. S. from Northridge Academy High School for the tip!

8. Avoid “enviro-speak.” For example, some students use words like “pollution,” generally. You should always specify the type of pollution. Thanks to Ms. B. from East Carolina University for the tip!

9. Include obvious details. No detail is too small for the FRQ! Include obvious details, such as “light is necessary for photosynthesis.” Most points are given for the basics. Thanks to Dr. D. from John Burroughs School for the tip!

10. Outline your answer. Think ahead before you begin to write. Create an outline on a separate sheet of paper or on the green packet of the AP exam. This helps to avoid confusion and disorganization and decreases the chances of rambling. Thanks to Mrs. P. from Grayslake North High School for the tip!

11. Participate fully in class lab activities. It is AP Environmental Science not AP Environmental Studies. Labs are a great way to learn important concepts in depth – something that can be hard to do through textbooks. Lab activities help develop your critical thinking skills and can help cement ideas in your mind for the exam. Thanks to Mr. G. from Kimball Union Academy for the tip!

12. Score sample FRQs. Try scoring one of your classmate’s free-response answers. Use rubrics and scoring guidelines from the CollegeBoard website to help you. This can give you a good insight into the AP reader’s perspective and show you just how much clarity, thoroughness, and neatness counts. Thanks to Mr. S. from Palos Verdes Peninsula High School for the tip!
13. **Simplify and organize your notes.** Organize your notes in a logical sequence. Simplify your notes by using graphic organizers, tables (issues, pros/cons, examples, etc.), terms, and figures. Thanks to Mr. K. from Camden Hills Regional High School for the tip!

14. **Look for the common thread.** On the AP Environmental Science exam, a free-response question might ask you to analyze how several topics from different parts of the course support a specific theme. Look for the common thread and answer each part of the question with respect to how that topic supports the theme. This type of question will allow you a choice of several topics, so choose the one you’re most comfortable with. Thanks to Mr. S. from Washington Township Public School District for the tip!

15. **Try not to second-guess the multiple-choice answers.** Changes usually are wrong. Trust your gut. Thanks to Mr. B. from Lakeland High School for the tip!

Are you a teacher or student? Do you have an awesome tip? Let us know!

AP Environmental Science has the power to be a really fun, engaging, and exciting class. The exam, however, will be difficult. Facts and vocabulary terms are especially important in APES and you must have knowledge of terms beyond just their definition. You have to be able to connect concepts together and understand the significance of key terms. Having good math skills is also important, so be sure to brush up on your algebra. Overall, as long as you’re dedicated to the course, use some of the study techniques in this post, and know what to expect on exam day, you’re on your way to a great score on the APES exam! Good luck!

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