Hints for doing well on the APES Exam

1. DO NOT STAY UP LATE STUDYING THE NIGHT BEFORE THE EXAM! Have your favorite snack and go to bed early. A clear, rested mind is the most important thing you can take to the AP Exam.
2. Dress comfortably and make sure to bring plenty of sharpened pencils and good erasers.
3. Think before you bubble. Read questions completely before answering. Eliminate careless mistakes.
4. Do not waste time on multiple-choice questions that are extremely difficult. Skip them; then return to them after you get warmed up.
5. Use leftover time to double check your answers.
6. On the free-response section, distribute the 90 minutes equally on the four essay questions (22 minutes each). Do not make the mistake of wasting a large percent of your time on one question, and then not having enough time to answer the other three.
7. Devote time to answering all the sections (a, b, c, d, etc.) for each essay question.
8. Take a few moments to think and organize your thoughts before you start to answer each essay question.
9. Write very clearly and large enough for the reader to read your words.
10. If you use diagrams, label and explain them. A diagram without an explanation gets zero points.
11. Eliminate "fluff." You don not need fancy introductions or conclusions on your essays. Get right to the point.
12. Be a point sponge! Write down what you know best, first. Think broadly when you are answering the essay questions; you have more information in your head than you realize. Don't forget to add detail and examples. Don't fabricate information that you don't know is true, it is a waste of time and will not earn any points.
13. Use underlining, especially if you are a poor writer, but be sure to give a full explanation. Just listing things will earn zero points.
14. If you are going to write down several points, write down the best ones first. Graders may be instructed to just grade the first one or two things you write, ignoring the rest.
15. When answering the essay questions, stay on the topics that are being asked. Do not add extraneous information that does not pertain to the question being asked.
16. Go in with a positive attitude—you have the knowledge to do a great job on this test!

More Hints for doing well on the APES Exam

1. YOU MUST SHOW YOUR WORK, be certain to write out all the steps clearly so the reader/grader can easily see and understand your work. Many students lose points because they do their math calculations in their heads or on a sheet of paper other that the answer sheet, and then fail to transfer the information onto the answer sheet.
2. No points are taken off for wrong or incorrect information, but simply writing a lot will not necessarily earn points—you must answer the question being asked. It is not uncommon for answers that fill two or three pages to earn no points.
3. Students will not receive points for restating the question. Embellishing and embroidering the question and then writing it down as an answer will receive no credit. Students must demonstrate knowledge and understanding.
4. Be careful when you interpret charts and graphs. Many students draw erroneous conclusions because the have misinterpreted a graph or chart.
5. Practice your math! Every AP Environmental Science student should be comfortable working with percentages, decimals, rounding, fractions, algebra, exponents, and scientific notation.
6. Outline form and bullets are not acceptable, answers must be written in prose style.
7. Students must demonstrate a deep understanding of the subject whether it's a biogeochemical cycle or a solar panel. Just throwing out terms, vocabulary and factoids is not enough.
8. 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.
9. Make sure, whenever possible, to support your statements with examples. Good examples will let the reader/grader know that you understand what you are talking about. Often, examples are required to earn some of the points available on a question.

APES Review

Definitions

Producer/Autotroph: organisms that make their own food. Photosynthetic life (plants).

Trophic Levels in Food Chains: producers → primary consumer → secondary consumer → tertiary consumer.

Photosynthesis: plants convert CO_2 (atmospheric carbon) into complex carbohydrates (glucose $C_6H_{12}O_6$).

Equation for photosynthesis: $CO_2 + H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6 + O_2$

Respiration (Aerobic): oxygen consuming producers, consumers & decomposers break down complex organic compounds & convert organic carbon back into CO_2.

Equation for respiration: $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O + \text{energy}$

Energy Flow through Food Webs: Only about 10% of usable energy is transferred from one trophic level to the next. Reason: usable energy lost as heat (2^{nd} law of Thermodynamics), not all biomass is digested & absorbed, predators expend energy to catch prey.

Biotic: the living components of an ecosystem.

Abiotic: the nonliving components of an ecosystem.

Nitrogen Fixation: atmospheric nitrogen (N_2), which cannot be used directly by plants, is first converted into ammonia by bacteria.

Nitrification: ammonia is converted to nitrate ions (NO_3^-).

Assimilation: inorganic nitrogen (nitrate) is converted into organic molecules such as DNA/amino acids & proteins.

Ammonification: decomposers covert organic waste into ammonia.

Denitrification: bacteria convert ammonia into atmospheric nitrogen (N_2).

Phosphorus: does not exist at the Earth's surface as a gas; released into ecosystems through the weathering of phosphate rocks, it is a major limiting factor for plant growth. The phosphorus cycle is relatively slow, without an atmospheric step.

Primary succession: development of communities in a lifeless area not recently inhabited by life (ex. lava flow, retreating glacier).

Secondary succession: life progresses where soil remains (ex. clear-cut/burned forest, old farm, vacant lot).

Mutualism/Symbiosis: symbiotic relationship where both organisms benefit.

Commensalism: symbiotic relationship where one organism benefits & the other is unaffected.

Parasitism: relationship in which one organism (the parasite) obtains nutrients at the expense of the host.

Carrying Capacity: the number of individuals that can be sustained in an area.

r-strategist: reproductive strategy in which organisms reproduce early, bear many small, unprotected offspring (ex. insects, mice).

K-strategist: reproductive strategy in which organisms reproduce late, bear few, cared for offspring (ex. humans, elephants).

Natural Selection: organisms that possess favorable adaptations pass them onto the next generation.

Humus: organic, dark material remaining after decomposition by microorganisms.

Loam: perfect agricultural soil with equal portios of sand, silt, and clay.

Leaching: the removal of dissolved material from soil by water as it moves downward (percolates) through soil.

Soil Conservation: Methods include conservation tillage, crop rotation, contour plowing, terracing, windbreaks, no-till.

Soil Salinization: in arid regions, water evaporates leaving salts behind. (ex. fertile crescent, southwestern US)

Waterlogging: water completely saturates soil starves plant roots of oxygen, rots roots

Watershed: all of the land that drains into a body of water.

Aquifer: underground layers of porous rock allow water to move slowly.

Saltwater Intrusion: near the coast, overpumping of groundwater causes saltwater to move into the aquifer.

ENSO: El Nino Southern Oscillation, trade winds weaken & warm surface water moves toward South America. Diminished fisheries off South America, drought in western Pacific, increased precipitation in southwestern North America, fewer Atlantic hurricanes.

La Nina: A "normal" year, easterly trade winds and ocean currents pool warm water in the western Pacific, allowing upwelling of nutrient rich water off the West coast of South America.

Doubling Time (rule of 70): the doubling time is equal to 70 divided by the percent rate of growth. (ex. a population growing at 5% annually doubles in $70 \div 5 = 14$ years)

Replacement Level Fertility: the number of children a couple must have to replace themselves (averages 2.1 in more developed nations, 2.7 in less developed nations).

World Population: approximately 6.5 billion.

US Population: approximately 300 million.

Demographic Transition Model:

Preindustrial stage: birth & death rates high, population grows slowly, infant mortality high.

Transitional stage: death rate (infant mortality) lower, birth rates remain high, better health care, population grows fast.

Industrial stage: decline in birth rate, population growth slows.

Postindustrial stage: low birth & death rates.

Age Structure Diagrams: broad base = rapid growth; narrow base = negative growth; uniform shape = zero growth

Most Populous Nations: (1) China; (2) India; (3) U.S.; (4) Indonesia

Composition of Water on Earth: 97.5% seawater, 2.5% freshwater.

Aquaculture: farming aquatic species, commonly salmon, shrimp, tilapia, oysters.

Point Source: source from specific location such as pipe or smokestack

Non-Point Source (Area/Dispersed/Fugitive Source): source spread over an area such as agricultural/feedlot runoff, urban runoff, traffic.

Eutrophication: rapid algal growth (algal bloom) caused by an excess of nitrogen & phosphorus (phosphorus usually limits), blocks sunlight, causing the death/decomposition of aquatic plants, decreasing dissolved oxygen (DO), suffocating fish.

Hypoxia: water with very low dissolved oxygen levels, the end result of eutrophication, for example.

Primary Sewage Treatment: first step of sewage (wastewater) treatment; eliminates most particulate material from raw sewage using grates, screens, and gravity (settling).

Secondary Sewage Treatment: second step of sewage treatment; bacteria break down organic waste, aeration accelerates the process.

Tertiary Sewage Treatment: final step of sewage treatment; ponds/wetlands used to remove nutrients nitrogen & phosporus.

BOD: Biological Oxygen Demand, amount of dissolved oxygen needed by aerobic decomposers to break down organic materials.

Turbidity: a measure of the cloudiness of water, caused by suspended solids (sediment).

Water Hardness: the result of dissolved calcium ions (Ca^{2+}) and magnesium (Mg^{2+}).

CAFE standards: Corporate Average Fuel Economy standards enacted into law in 1975, established fuel efficiency standards for passenger cars and light trucks. The fuel economy ratings for a manufacturer's entire line of passenger cars must currently average at least 27.5 mpg for the manufacturer to comply with the standard.

Primary Air Pollutants: produced by humans & nature (CO, CO_2, SO_2, NO, hydrocarbons, particulates).

Secondary Air Pollutants: formed via the atmospheric reaction of primary air pollutants.

Particulate Matter (PM2.5 & PM10): sources include burning fossil fuels and car exhaust. Effects include reduced visibility, respiratory irritation. Methods of reduction include filtering, electrostatic precipitators, and using alternative sources of energy.

Photochemical Smog: formed by chemical reactions involving sunlight (NOx, hydrocarbons, O_2).

Ozone: Secondary pollutant, $NO_2 + UV \rightarrow NO + O$; $O + O_2 \rightarrow O_3$, with VOCs. Causes respiratory irritation and plant damage. Reduced by reducing NO emissions and VOCs.

Nitrogen Oxides: (NO_x) Major source is auto exhaust. Primary and secondary effects include acidification of lakes, respiratory irritation, leads to smog and ozone. Reduced using catalytic converters.

Equation for acid formation: $NO + O_2 \rightarrow NO_2 + H_2O \rightarrow HNO_3$ (nitric acid)

Acid Deposition: caused by sulfuric and nitric acids formed from NO_x and SO_x resulting in lowered pH of surface waters

Sulfur Oxides: (SO_x) Primary source is coal burning. Primary and secondary effects include acid deposition, respiratory irritation, plant damage. Reduction methods include: scrubbers, burn low sulfur fuel.

Equation for acid formation: $SO_2 + O_2 \rightarrow SO_3 + H_2O \rightarrow H_2SO_4$ (sulfuric acid)

Carbon Dioxide: (CO_2) Sources include the combustion of fossil fuels. Effects: greenhouse gas–contributes to global warming. Reduction accomplished by increased fuel efficiency (gas mileage), mass transit (reduction).

Carbon Monoxide: (CO) Sources include incomplete combustion of fossil fuels. Effects: binds to hemoglobin reducing bloods ability to carry O_2. Reduction accomplished by catalytic converters, oxygenated fuel, mass transit (reduction).

Greenhouse Effect: a vital process, required for life to exist on Earth. When accelerated, leads to global warming.

Greenhouse Gases: Most significant (not anthropogenic) – H_2O. Also (and largely anthropogenic) – CO_2, methane (CH_4), and CFCs. Trap outgoing infrared energy (heat) causing earth to warm.

Effects of Global Warming: rising sea level (due primarily to thermal expansion, not melting ice), extreme weather, droughts (famine), and extinctions.

Ozone Depletion: caused by CFCs, methyl chloroform, carbon tetrachloride, halon, methyl bromide all of which attack stratospheric ozone. Negative effects of ozone depletion include increased UV, skin cancer, cataracts, and decreased plant growth.

Municipal Solid Waste: is mostly paper and mostly put into landfills.

Sanitary Landfill: problems include leachate, which is solved using a liner with a collection system; methane gas, which may be collected and burned; and the volume of garbage, which may be compacted and/or reduced.

Incineration: Advantages–volume of waste reduced by 90% and waste heat can be used. Disadvantages–toxic emissions (polyvinyl chloride, dioxin), scrubbers and electrostatic precipitators needed, ash disposal.

Reduce: The best solution for the solid waste problem is to reduce the amount of waste at the source.

Reuse: A low tech, low energy solution for the solid waste problem.

Recycle: Superior to landfilling waste. Conserves resources, reduces the need for ongoing mining operations.

Brownfield: an abandoned industrial site.

Remediation: return a contaminated area to its original state.

Keystone Species: species whose role in an ecosystem is more important than others.

Indicator Species: species that serve as early warnings that an ecosystem is being damaged.

Insecticides: chlorinated hydrocarbons (ex. DDT); organophosphates (ex. Malathion); carbamates (ex. Aldicarb)

Pesticide Advantages: saves lives by preventing insect transmitted disease, increases food supply, and increases profits for farmers. Disadvantages: genetic resistance, ecosystem imbalance, pesticide treadmill, persistence in the environment, bioaccumulation, and biological magnification.

Natural Pest Control: better agricultural practices, genetically resistant plants, natural enemies, and biopesticides, sex attractants.

Genetically Modified Organisms (GMOs): new organisms created by altering the genetic material (DNA) of existing organisms; usually in an attempt to remove undesirable or create desirable characteristics in the new organism.

Electricity Generation: steam, from water boiled by fossils fuels or nuclear energy, or falling water is used to turn a generator.

Petroleum (Crude Oil): formed as microscopic aquatic organisms in sediments are converted by heat & pressure into a mixture of hydrocarbons. Advantages: cheap, easily transported, high-quality energy. Disadvantages: reserves depleted soon, pollution and land subsidence during drilling, pollution during transport and refining, burning produces CO_2.

Coal Formation: prehistoric plants buried un-decomposed in oxygen-depleted water of swamps/bogs converted by heat and pressure.

Ranks of Coal: peat, lignite, sub-bituminous coal, bituminous coal, anthracite coal.

Nuclear Reactor: consists of a core, control rods, moderator, steam generator, turbine, containment building.

Alternate Energy Sources: wind, solar, waves, tides, biomass, geothermal, fuel cells

First Law of Thermodynamics: energy is neither created nor destroyed, but may be converted from one form to another.

Second Law of Thermodynamics: when energy is changed from one form to another, some useful energy is always degraded into lower quality energy (usually heat).

Ionizing radiation: radiation w/enough energy to free electrons from atoms forming ions, may cause cancer (ex. gamma, X-rays, UV).

High Quality Energy: organized & concentrated, can perform useful work (ex. fossil fuels & nuclear).

Low Quality Energy: disorganized, dispersed (ex. heat in ocean or air/wind, solar).

Natural radioactive decay: unstable radioisotopes decay releasing gamma rays, alpha & beta particles (ex. Radon).

Half-life: the time it takes for ½ of the mass of a radioisotope to decay. A radioactive isotope must be stored for approximately 10 half-lives until it decays to a safe level.

Nuclear Fission: nuclei of isotopes split apart when struck by neutrons. Used in nuclear power generation.

Nuclear Fusion: Two isotopes of light elements (hydrogen) are forced together at high temperatures until they fuse to form a heavier nucleus. Occurs in the Sun. Difficult and prohibitively expensive to accomplish on Earth.

Control rod: composed of a material (ex. cadmium or boron) that absorbs neutrons. Used to restrict the reaction in a nuclear reactor.

Fuel rod: rod-shaped mechanism which introduces fissionable nuclear material (ex. U-235) into a nuclear reactor.

Moderator: the media in which the nuclear fission reaction in a nuclear reactor takes place (water or graphite). Slows down neutrons.

Yellowcake: form into which uranium ore is converted for transport prior to enrichment.

Ore: a rock that contains a large enough concentration of a mineral making it profitable to mine.

Mineral Reserve: identified deposits currently profitable to extract.

Surface mining (Strip Mining): inexpensive, can remove more minerals, less hazardous to workers.

Sub-Surface mining: expensive and time consuming, incapable of removing all minerals, dangerous to workers.

LD-50: (Lethal Dose - 50%) the amount of a substance that kills 50% of the organisms in a test population

Troposphere: first layer of atmosphere 0-10 miles above the Earth's surface. Contains weather, greenhouse gases (bad ozone).

Stratosphere: second layer of atmosphere 10-30 miles above the Earth's surface. Contains protective ozone layer (good ozone).

Inversion Layer (Temperature Inversion): a warm layer of air above a cooler layer traps pollutants close to the Earth's surface.

Mutagen: substances that cause changes in DNA; may result in hereditary changes.

Teratogen: substances that cause fetus deformities (birth defects).

Carcinogen: substances that cause cancer.

Dioxin: one of the most toxic human-made chemicals. Stable, long-lived, by-product of herbicide production enters environment as fallout from the incineration of municipal and medical waste and persists for many years.

PCBs (Polychlorinated Biphenyls): Stable, long-lived, carcinogenic chlorinated hydrocarbons. Produced by the electronics industry.

Multiple Use Public Lands: National Forest & National Resource (BLM) lands.

Moderately Restricted Use Public Lands: National Wildlife Refuges.

Restricted Use Public Lands: National Parks & National Wilderness Preservation System.

Divergent Plate Boundaries: tectonic plates spreading apart, new crust being formed (ex. mid-ocean ridges, rift valleys).

Convergent Plate Boundaries: tectonic plates with the oldest crustal material on Earth moving together, one moving under another (ex. mid-ocean trenches). Mineral deposits and volcanoes are most abundant at convergent plate boundaries

Transform Fault: tectonic plates sliding past one another (ex. San Andreas fault).

Endangered Species

Most Endangered Species: have a small range, require large territory, have long generations, have a very specialized niche, or live on an island.

Atlantic Salmon: interbreeding with and competition from escaped farm-raised salmon from the aquaculture industry threaten the wild salmon population.

California Condor: reasons for decline include shootings, poisoning, lead poisoning, collisions with power lines, egg collecting, pesticides, habitat loss, and the decline of large and medium-size native mammals due to encroachments of agriculture and urbanization.

Gray Wolf: subject of predator eradication programs sponsored by the Federal government. Prior to Endangered Species Act (1973), exterminated from the lower 48 states except for a few hundred inhabiting extreme northeastern Minnesota and a small number on Isle Royale, Michigan

Grizzly Bear: conflict with humans and development that resulted in habitat loss and fragmentation

Piping Plover: predation and human disturbance are thought to be the main causes of the plover's decline. It is listed as endangered in the Great Lakes region and as threatened in the Great Plains and on the Atlantic coast

Manatee: initial population decreases resulted from overharvesting for meat, oil, and leather. Today, heavy mortality occurs from accidental collisions with boats and barges, and from canal lock operations.

Whooping Crane: drainage of wetlands, conversion of grasslands to agriculture, and hunting for feathers.

NOT Endangered Species

American Alligator: overhunting and destruction of habitat caused original listing, removed from the list of endangered species by the Fish and Wildlife Service in 1987.

Bald Eagle: ingested DDT by eating contaminated fish. The pesticide caused the shells of the bird's eggs to thin and resulted in nesting failures. Loss of nesting habitat and hunting for feathers also contributed to the population decline. Reclassified from endangered to threatened (1995).

Peregrine Falcon: ingested DDT by eating smaller birds, which had eaten contaminated prey. The pesticide caused the shells of the bird's eggs to thin and resulted in nesting failures. Removed from the list of endangered species by the Fish and Wildlife Service in August 1999.

Gray Whale: the eastern North Pacific stock of gray whale has the distinction of being the first population of a marine mammal species to be removed from the List of Endangered and Threatened Species.

Biomes

Biome: large distinct terrestrial region having similar climate, soil, plants & animals.

Tropical Rain Forests: characterized by the greatest diversity of species, believed to include many undiscovered species. Occur near the equator. Soils tend to be low in nutrients. Distinct seasonality: winter is absent, and only two seasons are present (rainy and dry).

Temperate Forests: occur in eastern North America, Japan, northeastern Asia, and western and central Europe. Dominated by tall deciduous trees. Well-defined seasons include a distinct winter. Logged extensively, only scattered remnants of original temperate forests remain.

Boreal Forests or Taiga: represent the largest terrestrial biome. Dominated by needleleaf, coniferous trees. Found in the cold climates of Eurasia and North America: two-thirds in Siberia with the rest in Scandinavia, Alaska, and Canada. Seasons are divided into short, moist, and moderately warm summers and long, cold, and dry winters. Extensive logging may soon cause their disappearance.

Temperate Shrub Lands: occurs along the coast of Southern California and the Mediterranean region. Characterized by areas of Chaparral–miniature woodlands dominated by dense stands of shrubs.

Savannas: grassland with scattered individual trees. Cover almost half the surface of Africa and large areas of Australia, South America, and India. Warm or hot climates where the annual rainfall is 20-50 inches per year. The rainfall is concentrated in six or eight months of the year, followed by a long period of drought when fires can occur.

Temperate Grasslands: dominated by grasses, trees and large shrubs are absent. Temperatures vary more from summer to winter, and the amount of rainfall is less than in savannas. Temperate grasslands have hot summers and cold winters. Occur in South Africa, Hungary, Argentina, the steppes of the former Soviet Union, and the plains and prairies of central North America.

Deserts: covers about one fifth of the Earth's surface and occur where rainfall is less than 50 cm/year. Most deserts occur at low latitudes, have a considerable amount of specialized vegetation, as well as specialized animals. Soils have abundant nutrients, need only water to become productive, and have little or no organic matter. Common disturbances include occasional fires or cold weather, and sudden, infrequent, but intense rains that cause flooding.

Tundra: treeless plains that are the coldest of all the biomes. Occur in the arctic and Antarctica. Dominated by lichens, mosses, sedges, and dwarfed shrubs Characterized by extremely cold climate, permanently frozen ground (permafrost) low biotic diversity, simple vegetation structure, limitation of drainage, short season of growth and reproduction.

Wetlands: areas of standing water wet all or most of the year that support aquatic plants including marshes, swamps, and bogs. Species diversity is very high. Includes bogs, swamps, sloughs, marshes

Fresh Water: defined as having a low salt concentration (less than 1%). Plants and animals are adjusted to the low salt content and would not be able to survive in areas of high salt concentration (i.e., ocean). There are different types of freshwater regions: ponds and lakes, streams and rivers, and estuaries.

Oceans: the largest of all the ecosystems. The ocean regions are separated into separate zones: intertidal, pelagic, abyssal, and benthic. All four zones have a great diversity of species.

Places to Know

Chernobyl, Ukraine: April 26, 1986, unauthorized safety test (irony), leads to fire and explosion at nuclear power plant—millions exposed to unsafe levels of radiation.

Three-Mile Island, Pennsylvania: March 29, 1979, nuclear power plant loses cooling water 50% of core melts, radioactive materials escape into atmosphere, near meltdown (disaster).

Yucca Mountain, Nevada: controversial as proposed site for permanent storage of high-level nuclear waste, 70-miles northwest of Las Vegas, near volcano and earthquake faults.

Aral Sea, Uzbekistan/Kazakhstan (former Soviet Union): large inland sea is drying up as a result of water diversion.

Love Canal, NY: chemicals buried in old canal, school and homes built over it led to birth defects and cancers.

Aswan High Dam, Egypt: the silt that made the Nile region fertile fills the reservoir. Lack of irrigation controls causes waterlogging and salinization. The parasitic disease schistosomiasis thrives in the stagnant water of the reservoir.

Three Gorges Dam, China: world's largest dam on Yangtze River will drown ecosystems, cities, archeological sites, fragment habitats, and displace 2 million people.

Ogallala Aquifer: world's largest aquifer; under parts of Wyoming, South Dakota, Nebraska, Kansas, Colorado, Oklahoma, New Mexico, and Texas (the Midwest). Holds enough water to cover the U.S. with 1.5 feet of water. Being depleted for agricultural and urban use.

Minamata, Japan: mental impairments, birth defects, and deaths were caused by mercury dumped in Minamata Bay by factory. Mercury entered humans through their diet (fish).

Bhopal, India: December 2,1984, methyl isocyanate released accidentally by Union Carbide pesticide plant kills over 5,000.

Valdez, Alaska: March 24, 1989, tanker Exxon Valdez hits submerged rocks in Prince William Sound—worst oil spill in US waters.

Environmental Laws and Treaties

Safe Drinking Water Act: set maximum contaminant levels for pollutants that may have adverse effects on human health.

Clean Water Act: set maximum permissible amounts of water pollutants that can be discharged into waterways. Aim: to make surface waters swimmable and fishable.

National Environmental Policy Act (NEPA): Environmental Impact Statements must be completed before any project affecting federal lands can be started.

Clean Air Act: Set emission standards for cars, and limits for release of air pollutants.

Kyoto Protocol: sets greenhouse gas emission reduction targets for developed countries. Not ratified by US or Australia.

Montreal Protocol: phases out the production and use of ozone depleting substances (ex. CFCs).

Resource Conservation & Recovery Act (RCRA): controls hazardous waste with a cradle to grave monitoring system.

Comprehensive Environmental Response, Compensation & Liability Act (CERCLA): The "Superfund" act, designed to identify and clean up abandoned hazardous waste dumpsites.

Endangered Species Act (ESA): identifies threatened and endangered species in the US, and puts their protection ahead of economic considerations.

Convention on International Trade in Endangered Species (CITES): lists species that cannot be commercially traded as live specimens or wildlife products.

Lacey Act: prohibits interstate transport of wild animals dead or alive without federal permit.

U.S. Marine Mammal Protection Act: prohibits taking marine mammals in U.S. waters and by U.S. citizens, and the importing marine mammals and marine mammal products into the U.S.

Surface Mining Control & Reclamation Act: requires coal strip mines to reclaim the land.

Low-Level Radioactive Policy Act: all states must have facilities to handle low-level radioactive wastes.

Nuclear Waste Policy Act: US government must develop a high level nuclear waste site by 2015 (see Yucca Mountain).

Ocean Dumping Ban Act: bans ocean dumping of sewage sludge & industrial waste.

People to Know

Rachel Carson: published *Silent Spring* in 1962; documented the environmental damage done by DDT and other pesticides. Which heightened public awareness at the start of the modern environmental movement.

John Muir: founded Sierra Club in 1892; fought unsuccessfully to prevent the damming of the Hetch Hetchy Valley in Yosemite National Park.

Gifford Pinchot: first chief of the US Forest Service; advocated managing resources for multiple use using principles of sustainable yield.

Garrett Hardin: published "The Tragedy of the Commons" in the journal *Science* in 1968; argued that rational people will exploit shared resources (commons).

Aldo Leopold: wrote *A Sand County Almanac* published a year after his death in 1948; promoted a "Land Ethic" in which humans are ethically responsible for serving as the protectors of nature.

Sherwood Rowland & Mario Molina: in 1974, determine that CFCs destroy stratospheric (good) ozone.

Thomas Malthus: "human population cannot continue to increase. Consequences will be war, famine & pestilence (disease)."

APES Chemistry Review

Basics

→ Neutrons, protons, and electrons are the components of atoms, which combine to form molecules.

→ The basic unit of all chemical compounds, whether natural or man-made, is the molecule.

Abbreviations

C ≡ carbon	S ≡ sulfur	U ≡ uranium	Cl_2 ≡ chlorine
O_2 ≡ oxygen	N_2 ≡ nitrogen	H_2 ≡ hydrogen	P ≡ phosphorus
NO_2^{-1} ≡ nitrite	NO_3^{-1} ≡ nitrate	SO_4^{-2} ≡ sulfate	NH_3 ≡ ammonia

NO_x ≡ oxides of nitrogen or nitrogen oxides (NO, NO_2)

SO_x ≡ oxides of sulfur or sulfur oxides (SO_2, SO_3)

VOC ≡ volatile organic compounds (compounds containing carbon which readily evaporate, ex. methane, benzene)

PAN ≡ peroxyacyl nitrates

pH

→ pH is the negative log of the hydrogen ion concentration (sometimes called the potential of hydrogen ion).

→ Mathematically it is represented by the equation: $pH = -\log[H^+]$ or $pH = -\log[H_3O^+]$

→ $[H^+]$ is the molarity (# of moles per liter) of H^+ ions

→ $[H^+]$ and $[H_3O^+]$ are essentially the same. H_3O^+ is called the hydronium ion, it results when H^+ are in water.

→ Low pH corresponds to being more acidic. High pH corresponds to being more basic.

→ The opposite of acidic is basic.

→ The range of pH is from 0 to 14.

pH=1 ∴ $[H^+]=1 \times 10^{-1}$ moles/liter (very acidic)	pH=4 ∴ $[H^+]=1 \times 10^{-4}$ moles/liter (acidic)
pH=6 ∴ $[H^+]=1 \times 10^{-6}$ moles/liter (slightly acidic)	pH=7 ∴ $[H^+]=1 \times 10^{-7}$ moles/liter (neutral)
pH=8 ∴ $[H^+]=1 \times 10^{-8}$ moles/liter (slightly basic)	pH = 13 ∴ $[H^+]=1 \times 10^{-13}$ moles/liter (very basic)

Nuclear Fission

→ Nuclear fission (splitting atoms) is the source of energy in today's nuclear power plants. The reactions used are chain reactions, in which one neutron initiates the reaction of millions of Uranium nuclei.

1 U-235 + 1 n → 1 Kr-92 + 1 Ba-141 + 3 n + energy (the 3 neutrons (n) initiate further reactions)

3 U-235 + 3 n → 3 Kr-92 + 3 Ba-141 + 9 n + energy (the 9 neutrons initiate further reactions)

9 U-235 + 9 n → 9 Kr-92 + 9 Ba-141 + 27 n + energy (the 27 neutrons initiate further reactions)

This continues until there are millions of neutrons being produced and millions of times more energy, as well.

→ A moderator and control rods are used to absorb neutrons to prevent the chain reaction from getting out of control which would result in a meltdown.

Air Pollution in the Troposphere

→ All fossil fuels contain large amounts of carbon (from the molecules of decomposed lifeforms). The combustion of fossil fuels (reaction with oxygen) produces carbon dioxide and carbon monoxide:

$$C + O_2 \rightarrow CO_2$$ (the #1 man-made greenhouse gas)

$$2C + O_2 \rightarrow 2CO$$ (incomplete combustion)

→ Coal may also contain sulfur which reacts during combustion:

$$S + O_2 \rightarrow SO_2$$

→ During combustion, the nitrogen that composes 80% of the air in the troposphere reacts:

$$N_2 + O_2 \rightarrow 2NO$$

→ The reactions above all show the formation of primary air pollutants

→ Primary air pollutants undergo reactions in the atmosphere to form secondary air pollutants.

Photochemical Smog

$$2NO + O_2 \rightarrow 2NO_2$$ (causes brownish haze)

$$NO_2 + \text{UV light} \rightarrow NO + O$$ followed by:

$$O + O_2 \rightarrow O_3$$ (O_3 is ozone and is very hazardous to plants, animals, and materials in the troposphere)

$$\text{hydrocarbons} + O_2 + NO_2 \rightarrow \text{PANs}$$ (peroxyacyl nitrates cause burning eyes and damage vegetation)

Acid Precipitation

$$3NO_2 + H_2O \rightarrow 2HNO_3 + NO$$ (HNO_3 is nitric acid and causes acid precipitation)

$$2SO_2 + O_2 \rightarrow 2SO_3$$ followed by:

$$SO_3 + H_2O \rightarrow H_2SO_4$$

→ Acid deposition can be neutralized by the addition of lime ($CaCO_3$) which is a base (a base will neutralize an acid)

Air Pollution in the Stratosphere

The reaction that is supposed to happen, which protects the Earth from UV light

$$2O_3 + \text{UV light} \rightarrow 3O_2$$

The destruction of ozone by CFCs

$$CCl_3F + \text{UV light} \rightarrow CCl_2F + Cl$$ (CCl_3F is a CFC) followed by:

$$Cl + O_3 \rightarrow ClO + O_2$$ followed by:

$$ClO + O \rightarrow Cl + O_2$$ followed by:

$$Cl + O_3 \rightarrow ClO + O_2$$ (same as first step above) followed by:

$$ClO + O \rightarrow Cl + O_2$$ (same as second step above) followed by:

(these reactions are repeated thousands of times to destroy thousands of ozone molecules)

APES Mathematics Review

The APES Examination will require you to do mathematical calculations. Occasionally these calculations may be somewhat esoteric, and you may find it possible to do them in your head; nonetheless, it is mandatory to show all work for all calculations on the free-response section of the APES exam. This worksheet is designed help to prepare you for the type of calculations you may encounter on this year's APES exam.

Use a separate piece of paper, and for each problem, show every step of your work, and indicate the cancellation of all units…No Calculators!!

Scientific Notation—All APES students should be able to work comfortably with numbers in scientific notation.

- Place the following numbers into scientific notation.

1. one billion
2. twenty three thousand
3. 70 trillion
4. three hundred

- Do the following calculations in scientific notation.

5. five hundred billion times thirty five thousand
6. six thousand divided by 300 billion
7. one ten thousandth of three million
8. 6 billion divided by 35 trillion

Unit conversions—All APES students should be able to convert from one system of units to another.

- Use Appendix C to complete the following. Show all of your work including the canceling of all units.

9. A 100 square mile area of national forest is how many acres? how many hectares?
10. A city that uses ten billion BTUs of energy each month is using how many kilowatt-hours of energy?
11. Fifty eight thousand kilograms of solid waste is equivalent to how many metric tons?
12. If one barrel of crude oil provides six million BTUs of energy, how many BTUs of energy will one liter of crude oil provide? How many calories of energy will one gallon of crude oil provide?
13. For crude oil, if 150 pounds of CO_2 is released per million BTUs of energy, how much CO_2 is produced by each barrel of crude oil? (use information from the previous problem)

Percentages—All APES students should be able to work comfortably with percentages.

14. A natural gas power plant is 60% efficient. If one cubic meter of natural gas provides 1000 BTUs of electricity. How many BTUs of waste heat were produced?
15. If 35% of a natural area is to be developed, leaving 500 acres untouched, how many acres are to be developed?
16. Calculate the percentage growth rate for a country with a population of 6 million: in a year in which it had 100,000 births, 70,000 deaths, 30,000 immigrants, and 50,000 emigrants.
17. If the concentration of mercury in a water supply changes from 65 ppm to 7 ppm in a ten-year period, what is the percentage change of the mercury concentration?

Energy—The APES exam always has questions about energy use. Be prepared!

- One BTU is the energy required to raise the temperature of one pound of water by one degree Fahrenheit.
- The density of water is 1 gram/milliliter or approximately 8 pounds/gallon (U.S.).

18. How much energy is required to raise the temperature of one thousand gallons of water by 25°F?
19. By how many degrees Fahrenheit can the temperature of one metric ton of water be raised with the addition of 110 thousand BTUs of heat?
20. If 500 thousand BTUs of energy are available to raise the temperature of a water boiler from 20°F to 100°F, how many gallons of water can be added to the boiler?