

APES Review

Definitions

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 1/2 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.

Nuclear Fusion: 2 isotopes of light elements (H) forced together at high temperatures till they fuse to form a heavier nucleus. Happens in the Sun, very difficult to accomplish on Earth, prohibitively expensive.

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: cheaper, can remove more minerals, less hazardous to workers.

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

Leaching: removal of dissolved materials from soil by water moving downwards through soil.

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

Soil Conservation Methods: conservation tillage, crop rotation, contour plowing, organic fertilizers.

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

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

Hydrologic Cycle Components: evaporation, transpiration, runoff, condensation, precipitation, and infiltration.

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

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

Cone of Depression: lowering of the water table around a pumping well.

Salt Water 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: "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.

Nitrogen Fixation: because atmospheric N cannot be used directly by plants, it must first be converted into ammonia by bacteria.

Ammonification: decomposers convert organic waste into ammonia.

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

Assimilation: inorganic N is converted into organic molecules such as DNA/amino acids & proteins.

Denitrification: bacteria convert ammonia back into N.

Phosphorus: does not exist as a gas; released by weathering of phosphate rocks, it is a major limiting factor for plant growth. Phosphorus cycle is slow, and not atmospheric.

Photosynthesis: plants convert CO_2 (atmospheric carbon) into complex carbohydrates (glucose $\text{C}_6\text{H}_{12}\text{O}_6$).

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

Biotic: the living components of an ecosystem.

Abiotic: the nonliving components of an ecosystem.

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

Trophic Levels: producers → primary consumer → secondary consumer → tertiary consumer.

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

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: 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.

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

Doubling Time: (rule of 70) doubling time equals 70 divided by percent growth rate. (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: a little over 6 billion.

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

Low Status of Women: Most important factor keeping population growth rates high.

Methods to Decrease Birth Rates: family planning, contraception, economic rewards & penalties.

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 Source): source spread over an area such as agricultural/feedlot runoff, urban runoff, traffic.

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

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

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

Eutrophication: rapid algal growth (algal bloom) caused by an excess of nitrogen & phosphorus, 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.

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, CO₂, SO₂, NO, hydrocarbons, particulates).

Secondary Air Pollutants: formed by reaction of primary pollutants.

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

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: $\text{NO} + \text{O}_2 \rightarrow \text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3$.

Ozone: Secondary pollutant, $\text{NO}_2 + \text{UV} \rightarrow \text{NO} + \text{O}$; $\text{O} + \text{O}_2 \rightarrow \text{O}_3$, with VOCs. Causes respiratory irritation and plant damage. Reduced by reducing NO emissions and VOCs.

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: $\text{SO}_2 + \text{O}_2 \rightarrow \text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$

Carbon Dioxide: (CO₂) 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 blood's ability to carry O₂. Reduction accomplished by catalytic converters, oxygenated fuel, mass transit (reduction).

Photochemical Smog: formed by chemical reactions involving sunlight (NO, VOC, O₂)

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

Greenhouse Gases: Most significant: H₂O, CO₂, methane (CH₄), CFCs. Trap outgoing infrared energy (heat) causing earth to warm.

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

Effects of Global Warming: rising sea level (due 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.

Best Solution for Waste Problem: reduce the amount of waste at the source.

Brownfield: abandoned industrial sites.

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.

In Natural Ecosystems: 50-90% of pest species are kept under control by: predators, diseases, parasites.

Major Insecticide Groups: chlorinated hydrocarbons—ex. DDT; organophosphates—ex. malathion; carbamates—ex. aldicarb

Pesticide Pros: saves lives from insect transmitted disease, increases food supply, and increases profits for farmers. Cons: genetic resistance, ecosystem imbalance, pesticide treadmill, persistence, 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 fossil fuels or nuclear energy, or falling water is used to turn a generator.

Petroleum (Crude Oil) Formation: microscopic aquatic organisms in sediments converted by heat & pressure into a mixture of hydrocarbons.

Petroleum Pros: cheap, easily transported, high-quality energy. Cons: reserves depleted soon, pollution during drilling, transport and refining, land subsidence, burning oil produces CO₂.

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

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

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

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

Remediation: return a contaminated area to its original state.

LD-50: the amount of a chemical that kills 50% of the animals 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 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.

Delhi Sands Flower-Loving Fly: a 1-inch long insect currently restricted to only 12 known populations in San Bernardino and Riverside counties. An estimated 98% of its habitat has been converted to residential, agricultural, and commercial use.

Florida Panther: hunting and development that resulted in habitat loss and fragmentation.

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.

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

National Wild and Scenic Rivers Act: protects rivers with due to aesthetic, recreational, wildlife, historical, or cultural reasons.

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

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

National Environmental Policy Act (NEPA): Environmental Impact Statements must be done 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: controlling global warming by setting greenhouse gas emissions targets for developed countries.

Montreal Protocol: phase out of ozone depleting substances.

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

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

Endangered Species Act: 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.

Federal Insecticide, Fungicide, and Rodenticide Act: regulates the effectiveness of pesticides.

Food Quality Protection Act: set pesticide limits in food, & all active and inactive ingredients must be screened for estrogenic/endocrine effects.

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).

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.