

Objective: To review the major concepts covered on the AP Environmental Science Exam

Note: This sheet is structured differently than we covered the topics in class, but its mostly the same.

Environmental Ethics & History

1. There are different environmental perspectives, including *preservation*, *conservation*, and *exploitation*.
2. A person's environmental *footprint* is a measure of how much of the Earth's resources they consume.

Earth Systems

1. The Earth is approximately 4.5 billion years old.
2. A *system* can be isolated for the purpose of observing and measuring change. A *closed* system allows only energy to pass its borders, while an *open* system allows both matter and energy to pass its borders.
3. The four main spheres of the Earth are the *atmosphere* (air), *geosphere* (land), *biosphere* (life), and *hydrosphere* (water).
4. The Earth has a solid iron *core* surrounded by a liquid iron core. The liquid iron gives rise to the Earth's magnetic field, which protects us from high speed charged particles from the sun.
5. The bulk of the Earth is hot, high pressure rock known as the *mantle*. The outer surface is known as the *lithosphere* (crust).
6. *Continental* crust is thicker, older, and less dense than *oceanic* crust.
7. *Pangaea* was a large, single continent that existed over 200 million years ago.
8. The theory of *plate tectonics* states that the Earth is divided into 12 major plates that move around the surface of the earth (at very slow speeds).
9. The three major types of plate boundaries are *convergent*, *divergent*, and *transform* boundaries. Each type has specific properties and geologic features.
10. The water cycle, driven by the sun and gravity, determines how water moves through the hydrosphere. The major processes include *evaporation*, *condensation*, *transpiration*, *precipitation*, *infiltration*, and *run-off*. The major reservoirs include surface waters, ground water, ice, the atmosphere (including clouds), and the biosphere.
11. Only 3% of the Earth's water is freshwater.
12. A *watershed* is the area of land that drains into a body of water.
13. *Aquifers* are underground water supplies that can be confined or unconfined.
14. A volume of water can hold much more energy than an equal volume of air, and therefore water helps regulate the climate.
15. Salinity and temperature determine the density of ocean water.
16. The *thermohaline* circulation current (also known as the ocean conveyor belt) is driven by differences in temperature and salinity and transports energy around the world.
17. The four major types of volcanoes are shield, composite, cinder cone, and lava dome.
18. The Hawaiian islands were formed as a plate moved over a stationary *hot spot*, creating a series of volcanic islands.
19. The atmosphere is composed of approximately 78% nitrogen, 21 % oxygen, 0.9% argon, and 0.0392 % carbon dioxide (392 parts per million).
20. The layers of the atmosphere (from closest to ground toward space) are the troposphere, *stratosphere*, *mesosphere*, and *thermosphere*.
21. The *ozone layer* absorbs UV radiation and is located in the stratosphere.
22. The *Hadley*, *Ferrel*, and *polar cells* are convective currents in the atmosphere.
23. The *Coriolis effect* is the apparent curvature of global winds, ocean currents, and anything else that moves freely across the Earth's surface, due to the rotation of the Earth on its axis.

24. The seasons are caused by the tilt of the Earth's axis. The northern hemisphere is tilted toward the sun in summer and away in the winter, and the opposite is true for the southern hemisphere.
25. *Climate* consists of the long term patterns of temperature and precipitation for an area. *Weather* is the state of the atmosphere at a particular place and time.

Ecology and Biodiversity

1. *Evolution* is the change and differentiation of species over time. *Natural selection* explains how this occurs: Individuals that are best suited to their environment survive and reproduce most successfully.
2. *Energy* is the ability to do work or cause change.
3. *The First Law of Thermodynamics* states that energy is neither created nor destroyed, but may be converted from one form to another.
4. *The Second Law of Thermodynamics* states that when energy is changed from one form to another, some useful energy is always degraded into lower quality energy (usually heat)
5. *Autotrophs* (producers) produce their own food with photosynthesis. *Heterotrophs* (consumers) get their food by eating autotrophs or other heterotrophs.
6. *Photosynthesis* is the process by which plants convert the energy in sunlight into stored chemical energy. Carbon dioxide and water are converted into sugar and oxygen.
7. *Respiration* is the process by which both producers and consumers extract energy from sugars. Sugar and oxygen is converted to water and carbon dioxide.
8. The *net primary productivity* of producers is defined as the rate at which energy for use by consumers is stored in new *biomass* (cells, leaves, roots, and stems.)
9. The levels of organization increase from *populations* to *communities* to *ecosystems*.
10. Only about 10% of the energy available at each trophic level can be passed on to support the next level. Most is lost as heat to the environment.
11. Species interact with one another in an ecosystem and there are many different types of relationships (*predation, mutualism, commensalism, parasitism, etc.*)
12. A *terrestrial biome* is large ecological region defined by the dominant plant types and the climate (temperature and precipitation patterns).
13. Major *aquatic biomes* are defined by the salinity of the water (salt, fresh, or brackish).
14. *Biodiversity* has three major levels: ecosystem diversity, species diversity, and genetic diversity.
15. Major causes of biodiversity loss include habitat destruction, invasive species, pollution, overharvesting, and climate change.
16. *Invasive species*, such as the cane toad or kudzu, become dominant in a community and interfere with its normal functioning.
17. Biodiversity provides many benefits, including ecosystem services, food security, drugs and medicine, and ecotourism.
18. *Extirpation* is the extinction of a species from a given region only.
19. There have been five great extinction throughout history, and many scientists feel that humans are causing the sixth.
20. 99% of all species to have ever lived on Earth have gone extinct.
21. Species with certain characteristics, such as low birth rate or specialized eating habits, are more likely to go extinct.

Biogeochemical cycles

1. *Nutrients* are elements and compounds that organisms consume require for survival, such as carbon, nitrogen, and water.
2. *Reservoirs* are places where nutrients spend varying amounts of time and *fluxes* are the movement of these nutrients between reservoirs.
3. Major reservoirs in the carbon cycle include: the atmosphere, fossil fuels, organic molecules in organisms, the oceans, and rocks (limestone).

4. Major fluxes in the carbon cycle include: photosynthesis, respiration, combustion, decomposition, sedimentation and diffusion (ocean/atmosphere exchange).
5. Humans are affecting the carbon cycle by burning fossil fuels and causing deforestation.
6. The major fluxes in the nitrogen cycle include *fixation, nitrification, ammonification, assimilation, and denitrification*.
7. Humans are affecting the nitrogen cycle by using artificial fertilizers (*Haber Bosch process*) and combusting fossil fuels (nitrogen oxides).
8. *Eutrophication* is the process by which nutrient enrichment in water leads massive algae growth. When this algae then dies, the decomposition of the algae uses all the available oxygen, creating *hypoxic zones*.
9. The *rock cycle* describes how *sedimentary, metamorphic, and igneous rocks* are formed in a continuous process.
10. *Soil* is a complex mixture of organic and inorganic material full of living organisms whose actions keep it fertile.
11. *Weathering* refers to the physical, chemical, and biological processes by which rocks break down into smaller particles. Erosion is the movement of soil from one place to another.
12. The layers of soil are described as *horizons* and include the O, A, E, B, C, and R horizons.
13. The *soil texture* is determined by the mix of particle sizes in the soil. The size of particles (from smallest to largest) is *clay, silt, sand, and gravel*.
14. The *permeability* of a soil refers to its ability to allow water to pass through.

Population

1. *Population density* is the number of organisms per area.
2. *Population distribution* can be random, uniform, or clumped.
3. An *exponential* growth curve is a rapidly rising, J-shaped curve. A *logistic* growth curve begins to grow rapidly but then levels out at the *carrying capacity* (S-shaped curve).
4. *Limiting factors*, such as availability of food or spread of disease, can limit the growth of a population. These factors can be density dependent or density independent.
5. Species have different reproductive strategies. *K-strategists* have few offspring and care for them well, while *R-strategists* have many offspring with little parental care.
6. *Birth rate* is calculated as the number of births divided by the total population. *Death rate* is the number of deaths divided by the total population. (on an annual basis)
7. *Population growth rate* is births minus deaths divided by total population. If you need to include immigration/emigration, just make sure you account for them as well.
8. The *doubling time* for a population (in years) can be found by dividing 70 by the growth rate as a percent.
9. *Future population* can be found by multiplying the present population by $(1 + \text{growth rate as a decimal})^{\text{number of years}}$.
10. The current world population is about 6.9 billion people. The current U.S. population is about 310 million people..
11. China is the most populous country (1.3 billion), followed by India (1.15 billion), and then the U.S.
12. The IPAT model says that the impact of a country can be estimated as the population times the affluence times the technology.
13. The *total fertility rate* is the average number of children per woman in her lifetime.
14. Reasons for high population growth include the low status of women and lack of access to education and birth control.
15. The *age pyramid* allows us to visualize the demographic trends in a country (rapid growth, stability, or shrinkage). AIDS has caused a distinctive pyramid in which reproductive population is very small compared to the pre and post reproductive populations.

16. The *demographic transition* describes how population growth changes from pre-industrial stage to the transitional stage to the industrial stage and finally to the post-industrial stage.

Land Use and Resource Management

1. There are various ways to use land and its resources, including forestry, grazing, agriculture, mining, tourism, preservation, and urbanization.
2. In the U.S. nearly 40% of land is owned and managed by state and federal agencies, including the National Park Service, Bureau of Land Management, National Forest Service, and Fish and Wildlife Service.
3. Land use options include preservation, remediation/restoration, and sustainable use.
4. Succession describes the series of species replacements as a community changes. *Primary succession* occurs when there is no soil (volcanic island forms); *secondary succession* occurs when soil remains (after forest fire).
5. Habitat fragmentation occurs due to human development and can lead to increased edge effects.
6. *Deforestation* is occurring most rapidly in developing countries, as trees are cleared for fuel, building material, or farm land.
7. Importance of forests includes high biodiversity, stabilization of soil, purifying water and slowing runoff, storing carbon and releasing oxygen.
8. Methods of timber harvesting include clear cutting (most damaging), shelterwood approach, selection approach, and seed tree approach.
9. Wildfires are important events in ecosystems, but have grown in intensity because of human interference.
10. Mining includes strip-mining and deep mining, both of which can be environmentally damaging. Mining is one of the most dangerous professions in the world.
11. Mountain top removal is a method of strip mining for coal that is commonly used in West Virginia and other coal producing states. In this method, the overburden is dumped down the mountain, clogging streams, causing pollution, and altering habitat.
12. *Acid mine drainage* occurs when water mixes with exposed minerals to produce acidic runoff.
13. *Cyanide* is an extremely dangerous poison often used in gold mining.

Solid Waste and Urbanization

1. The population in much of the developing world is moving into cities (urbanization).
2. Urban sprawl occurs if the growth of an urban area results in significant reduction of the population density.
3. Smart growth uses the ideas of mass transit, upward building, and walkable neighborhoods to reduce urban sprawl.
4. Paper is the biggest component of the municipal waste stream.
5. Municipal waste is a very small percentage of total waste (industrial, agricultural, mining, etc.)
6. The 3 R's are reduce, reuse and recycle.
7. Americans generate about 4.5 lbs of municipal waste per day per person.
8. 33% is recycled, 12 % is incinerated, and 55% goes to a landfill.
9. Landfills are generally lined with plastic and clay to prevent contamination of groundwater.
10. Leachate is water that is contaminated by hazardous substances in a landfill.
11. Recycling an aluminum can is about 95% more energy efficient than obtaining the aluminum from bauxite ore.
12. The EPA program to cleanup hazardous waste sites is known as the Superfund.
13. Brownfields are properties that are contaminated with hazardous waste or pollutants.
14. A lifecycle analysis considers the entire lifetime of a product, from extraction of the materials to the disposal of the product, when analyzing the environmental impact.

Agriculture

1. Ways to protect soil include crop rotation, contour farming, terracing, and no-till farming.
2. 2 major problems from irrigation: salinization occurs when over watering leads to a buildup of salts in the soil. Waterlogging occurs when overwatering bathes the plant roots in water to the point that they cannot get the proper nutrients.
3. Overgrazing problems include soil erosion and compaction and encouragement of invasive species.
4. The Green Revolution was characterized by monocultures of higher yielding crops, more energy inputs (fossil fuels), and use of synthetic fertilizers.
5. Between 1961 and 2002, food production rose 150% and population rose 100% while area converted for agriculture increased only 10%.
6. 90% of the food we consume comes from 15 crop species and 8 livestock species.
7. Pests that are genetically resistant to pesticides lead to pesticide resistant "superpests".
8. Biological control of pests includes using ladybugs to eat aphids.
9. *Bacillus thuringiensis* (Bt) is a naturally occurring soil bacterium that produces a protein that kills many insects. It has been used in GMOs to create an internal pesticide.
10. Integrated pest management (IPM) uses many techniques, not just use of pesticides, to control pests.
11. There are many arguments for and against the use of genetically modified organisms (GMOs).
12. Factory farming has been criticized for poor treatment of animals, unsanitary conditions, and overuse of fertilizers and fossil fuels.
13. Beef requires the most land and water input to produce.
14. Aquaculture is the raising of fish and other aquatic organisms in controlled environments for food.
15. Sustainable agriculture is agriculture that does not deplete soils faster than they form.
16. To be labeled USDA organic, there should be conventional pesticide use, no GMOs, and no synthetic fertilizers.
17. The tragedy of the commons is the idea that a public resource will be overexploited for personal gain by individuals (ex. overfishing, overgrazing)
18. Commercial fishing methods include drift netting, bottom trawling, and longlining. By-catch refers to unintended capture of animals, such as dolphins.

Water Use

1. Globally, the biggest use of water is agriculture. In the U.S., it is thermoelectric power production followed by agriculture.
2. Overpumping groundwater can lead to subsidence of the ground, and in extreme cases sinkholes.
3. Salt water intrusion can occur in overpumped aquifers that are near the ocean.
4. China's Three Gorges dam is the largest dam project in the world.
5. Point sources of water pollution would include a factory. Non-point sources would include a large agricultural area.
6. Water pollution includes: nutrient pollution, pathogens and diseases, toxic chemicals, sediment, or thermal pollution.
7. 1.5 billion people lack access to clean drinking water and 3 billion people lack good sanitation need to prevent communicable diseases from spreading.
8. 75% of water pollution in the US come from soil erosion, atmospheric deposition and surface run off
9. 95% of water pollution in developing countries come from raw sewage (high population growth without the money for treatment plants)
10. Clean Water Act of 1972 regulated pollution and funded wastewater treatment, but did not regulate groundwater.
11. Organic wastes pollute water because they lower dissolved oxygen levels as bacteria decompose them
12. Higher temperature water holds less dissolved oxygen.

13. Fecal coliform bacteria is an indication of human or animal waste in the water.
14. Turbidity is a measure of the clarity of the water; the lower the turbidity the clearer the water.
15. pH is a measure of the acidity of a solution: 0 is most acidic, 7 is neutral, and 14 is basic.
16. Observing the biodiversity of macroinvertebrates in a creek can give you an idea of the water quality. If there are pollution intolerant creatures present, chances are there is little pollution.

Toxicology and Air Pollution

1. Bioaccumulation is the selective absorption and storage of a great variety of molecules
2. Biomagnification is a continued increase in the concentration of pollutants in higher levels of a food chain.
3. Acute effects are caused by a single exposure to a toxin and results in an immediate health crisis of some sort.
4. Chronic effects are long lasting and can result from a single exposure of a very toxic substance or a continuous exposure to the toxin.
5. LD50 is the amount of a chemical that kills 50% of the animals in a test population
6. Mutagen, Teratogen, Carcinogen: cause hereditary changes, fetus deformities, cancer
7. Threshold toxicity is the dose at which a substance begins to show an effect
8. Endocrine disruptors are chemicals that affect the hormonal system. Sometimes these chemicals have higher effects at lower doses.
9. Radon is a naturally occurring radioactive gas released from certain types of rocks, and can be a dangerous indoor air pollutant.
10. The EPA's six criteria air pollutants are: carbon monoxide (CO), sulfur dioxide (SO₂), nitrogen oxides (NO_x), lead, particulate matter, and ozone (O₃)
11. A volatile organic compound (VOC) is a dangerous chemical containing carbon that easily evaporates.
12. Industrial smog is mostly caused by sulfur and carbon from fossil fuel use.
13. Photochemical smog is formed when VOCs and NO_x compounds react with each other in the presence of sunlight to form ozone and other pollutants.
14. CFCs are compounds that degrade stratospheric ozone. They were banned globally with the Montreal Protocol in 1987.
15. Acid rain (acid deposition) is caused by sulfur dioxide and nitric oxide pollutants forming sulfuric acid (H₂SO₄) and nitric acid (HNO₃)
16. The biggest source of indoor air pollution is indoor cooking fires in developing countries.

Energy

1. About 85% of U.S. energy use is derived from fossil fuels.
2. Transportation is the biggest user of petroleum. Electricity production is the biggest user of coal.
3. Electricity is most commonly generated by using steam (from water boiled by fossil fuels or nuclear) to turn a generator
4. Petroleum forms from microscopic aquatic organisms in sediments converted by heat & pressure into a mixture of hydrocarbons
5. Pros of petroleum: cheap, easily transported, high quality energy
6. Cons of petroleum: reserves depleted soon, pollution during drilling, transport and refining, burning makes CO₂
7. Hubbert's peak is the point at which the peak in oil production will occur.
8. Natural gas is cleaner burning than coal or oil, but still produces CO₂ emissions.
9. Steps in coal formation: peat, lignite, bituminous, anthracite
10. Major parts of a nuclear reactor: core, control rods, steam generator, turbine, containment building
11. Two most serious nuclear accidents were Chernobyl, Ukraine and Three Mile Island, Pa

12. Natural radioactive decay occurs when unstable radioisotopes decay releasing gamma rays, alpha & beta particles
13. Half life is the time it takes for $\frac{1}{2}$ the mass of a radioisotope to decay
14. Estimate of how long a radioactive isotope must be stored until it decays to a safe level: approximately 10 half-lives
15. Nuclear Fission: nuclei of isotopes split apart when struck by neutrons. U^{235} used for conventional nuclear energy.
16. Nuclear Fusion: 2 isotopes of light elements (H) forced together at high temperatures till they fuse to form a heavier nucleus, Helium (He). Temp needs to be about 100 million degrees
17. Alternate energy sources include wind, solar, waves, biomass, geothermal, hydrogen fuel cells
18. A watt is a measure of power (energy/time). One watt is one joule per second. A kilowatt is 1000 watts. A kilowatt-hour is a measure of energy: 1 kilowatt-hour is the amount of energy a 1000 W device would use if operated for 1 hour.
19. Efficiency deals with the ability to convert more energy from one form to another without wasting it. Conservation is a behavior that reduces energy use in the first place.
20. A compact fluorescent light bulb (CFL) is about 4 times as efficient as an incandescent light bulb.

Climate Change

1. The greenhouse effect is a natural phenomenon and is necessary for life on Earth. The planet would be much colder (by about 33 C) without it.
2. Humans are increasing the concentration of greenhouse gases in the atmosphere, mostly through fossil fuel use and deforestation.
3. Greenhouse gases trap energy by allowing visible light (short wavelength radiation) to pass through from the sun, but then trap the infrared (long wavelength radiation) emitted by the Earth.
4. Greenhouse gases include carbon dioxide, methane, nitrous oxide (N_2O), and water vapor.
5. About 30% of incoming sunlight is reflected back into space because of the Earth's albedo.
6. Scientists use information from proxy measurements to find information about the past climate, such as tree rings or ice cores.
7. Physical impacts of climate change include warmer oceans and atmosphere, more severe weather events, changes in precipitation patterns, and rising sea levels (mainly due to thermal expansion of the oceans).
8. Biological impacts of climate change include extinction of species, migration of species, bleaching of coral reefs, spread of disease, and decreased crop yields in some locations.
9. The Kyoto protocol was an agreement drafted in 1997 that calls for reducing emissions of greenhouse gases to 1990 levels. The U.S. has refused to ratify the proposal.
10. The Intergovernmental Panel on Climate Change (IPCC) is an international panel of scientists and governmental leaders established by the UN to assess information relevant to human caused climate change.