**Water, Carbon, and Nitrogen Cycle**

According to the CSET test guide, there will be a total of 50 mutliple choice questions and three constructed response questions for CSET 122.

**a. Illustrate the mechanism that drives the water cycle**

The water cycle begins with the energy of the sun. The water cycle, also referred to as the hydrologic cycle, is a mental reference with what happens to water as it cycles through the earth. The large reservoir is the ocean because of the large solar radiation that is absorbed by the ocean, the water evaporates and gains energy. Because the ocean is so large, most of this water falls back into the ocean (short circuit). Very small amount of the water condenses into clouds and moves over land. So, you start with the transport from the ocean to the land (we are so concerned about the atmosphere as it is what transports the water). Some of it falls to earth in some form of precipitation, and then it splits off to different paths. A small amount infiltrates the ground (10 percent) and becomes groundwater. The crust consists of several layers, with some layers being porous and permeable while others are impermeable. As water moves through the permeable layer and reaches the impermeable layer, it begins to build up. We call this region the saturated zone. The region above this zone is called the unsaturated zone. The boundary between the two is called the water table.
Water may also be absorbed by the plant and released (transpiration) back into the atmosphere. 30 percent falls into rivers and eventually makes its way back to the ocean. Because water has different sized reservoirs and moves at different speeds, it spends very long in some reservoir and little in others. The ocean is so vast that it has a lot of storage. It takes a long time to move from one region to the next. Once in the atmosphere it takes a few days to get back into the ocean. In a river (no lakes), it takes a couple of weeks to get from the top of the mountain to get back to the ocean. One good thing about rivers is that if it's polluted, then it will clear out into the ocean. Water that infiltrates moves very slow. So, groundwater may take thousands, tens of thousands of years, to empty into river and then into the ocean or discharge directly into the ocean.

**Global Carbon Cycle**

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Complicated chain of events. Each one of them controls the other one. On the one hand, if you have too much of CaCo3, then it's removed by sedimentation (shells) and so forth. The oceans are crucial, the very important role (for the last 500 my) of maintaining the amount of co2 in the atmosphere. They are the buffers of the amount of co2 in the atmosphere. They also, due to the generation of the H they control the acidity of the ocean. The ocean is slightly more the the alkaline side. If I have 20degree pure water, a very tiny amount of the molecules in the water, are breaking naturally form hydrogen and oxygen> they then join again. As many as splitting are joining. At any time there are 10+-7, the pH means the amount pH 7, means the amount of hydrogen atoms present in the water. So, what is bigger, 10=7 or 10-5, 10-5 means hundred more times of hydrogen. So, it's more acidic. So, 10-3 is more acidic. 10-7 is bigger than 10-10 (have less, 10 would be like soap). The ocean happens to be somewhere around 7.8. Doesn't change much. Why? Because of the carbon cycle. The system is buffered so well, that if anything changes seriously, the reactions just turn the other way so that it maintains a constant amount of HC)o- and H+. You may have heard that global warming is increasing the co2, that will drive the reaction and thus change the acidity of the acid. But it can't, the system is buffered and remain it's acidity. The bad news is that the ocean needs a lot time, a lot of time to do these things. So, the co2 content of the atmosphere could rise quite a bit, the ocean this whole time is consuming it. By the time the oceans regulate the co2, we might not be around to see it.

**b. Compare the processes of photosynthesis and respiration in terms of reservoirs of carbon and oxygen**

**c. Identify the carbon reservoirs (i.e., physical and chemical forms of carbon in the atmosphere, oceans, biomass, soils, fossil fuels, and solid earth) and describe the movement of carbon among these reservoirs in the global carbon cycle**

Quick Background: Pure carbon atom is fairly rare in nature, and is primarily found in diamonds and graphite. Typically, carbon is chemically bounded to other atoms to form compounds (carbon dioxide, carbon monoxide, calcium carbonate, etc). Carbon is also an essential building block of life and is found bonded to hydrogen and oxygen to form organic compounds, necessary to compose living things.

Carbon is found in the atmosphere primarily as the greenhouse gas, carbon dioxide. Many processes on Earth requires the use of carbon dioxide. Thus, carbon is constantly being moved in and out of the atmosphere. Carbon is able to move through all four of the Earth's major spheres (biosphere, atmosphere, hydrosphere, and lithosphere).

Plants absorb carbon dioxide (biosphere) from the atmosphere in order to produce organic compounds that is necessary for growth. Then, animals who consume the plants, use the organic compounds that was produced by the plant as a source of energy. Through the process of respiration in plants, carbon dioxide is returned to the atmosphere. In addition, when plants die and decay, their biomass is oxidized and carbon dioxide is returned to the atmosphere. Small amounts of carbon dioxide may be deposited as sediment (lithosphere) when plants decay. After a long period of time, this decaying plant material may form become a fossil fuel. Burning of this fossil fuel releases large quantities of carbon dioxide back into the atmosphere. Volcanic eruption (lithosphere) spews out gases such as water vapors and carbon dioxide. Some carbon dioxide combines with water vapors to form carbonic acid which attacks rocks of the lithosphere. This chemical weathering of rock produces bicarbonate ion, which is carried by groundwater and streams into the ocean. Marine life extracts the dissolved ion to produce its hard parts (shells, for example) of calcium carbonate. When these marine creatures die, their skeleton parts fall to the sea floor and eventually becomes compacted and forms a sedimentary layer, with limestone being the most abundant (lithosphere). Through shifts and changes on Earth, the limestone may be exposed at the Earth's surface. Through chemical weathering, the carbon stored in the rock would be released into the atmosphere as carbon dioxide.

**d. Describe the nitrogen cycle as it relates to the atmosphere, soils as reservoirs, life processes, and pollution**

Organisms need nitrogen in order to make amino acids, proteins, and nucleic acids. Except for bacteria, organisms cannot use nitrogen directly from the atmosphere. In the atmosphere, nitrogen exists in the gaseous stage (N2). A specific kind of bacteria (contains nitrogenase enzymes) is able to bind the nitrogen atoms to hydrogen atoms to form ammonia ion, NH3, in a process known as nitrogen fixation. Plants can only take in nitrogen as either ammonium ion or nitrate ion. Bacteria in the soil converts ammonia into nitrates and nitrites during nitrification. Producers can take these substances in and use them to make proteins and other molecules. Consumers eat the producers, who in turn, uses these proteins to make new proteins. When organisms die, decomposers return the nitrogen back into the soil as ammonia. Bacteria may again change the ammonia into nitrates or nitrites or into nitrogen gas (denitrification, which is internal respiration by bacteria).

Pollution: Soluble nitrogen in oceanic waters limits the amount of growth of certain types of bacteria. However, through artificial fertilizers that is added to crop-lands results in run-off of soluble nitrogen into oceans. The addition of soluble nitrogen results in eutrophication (increase in the amount of artificial or natural substance in an environment). Nitrogen-driven bacteria grows and depletes the water of oxygen to the point that organisms begin to die.