Chapter 3: Water and the Fitness of the Environment

I. The polarity of water molecules results in hydrogen bonding

Because oxygen is more electronegative than hydrogen, the electrons of the polar bonds spend more time closer to the oxygen atom. Thus, the oxygen region of the molecule has a partial negative charge (δ−), and the hydrogen have a partial positive charge (δ+)

A hydrogen bond forms when the oxygen of one water molecule is electrically attracted to the hydrogen of a nearby molecule.

II. Properties of water

1. Cohesion

Hydrogen bonding keeps water molecules close to each other, and this cohesion helps pull water upward in the microscopic vessels of plants. Hydrogen bonding is also responsible for water’s surface tension.

Adhesion is the clinging of one substance to another. Adhesion of water to the walls of the cells helps counter the downward pull of gravity.

2. Specific Heat

The specific heat of a substance is defined as the amount of heat that must be absorbed or lost for 1 g of that substance to change its temperature by 1°C. Hydrogen bonding gives water a high specific heat.

3. Density

Ice is less dense than liquid water and this lower density causes ice to float.

Solution: a liquid that is a completely homogeneous mixture of two or more substances.
Solvent: is a dissolving agent of a solution (ex, water)
Solutes: is a substance that is dissolved (ex, salt)

Hydrophilic: substances have an affinity for water or water loving.
Hyrophobic: substances do not have an affinity for water or water fearing.
**Molarity:** is the number of moles of solute per liter of solution, and use as a measure of solute concentration in solutions. 

A mole is a certain number of molecules of a substance.

**Question:** how would you make a 0.5–molar (0.5 M) solution of sodium chloride (NaCl)? (The atomic mass of Na is 23 daltons and that of Cl is 35.5 daltons.)

**Dissociation of water**

Water can dissociate into $H^+$ and $OH^-$. 

$$H_2O \rightleftharpoons H^+ + OH^-$$

An acid: is a substance that increases the hydrogen ion concentration of a solution. A base: is a substance that reduces the hydrogen ion concentration of a solution by accepting hydrogen ions.

**OR -**

Acids is a substance that donates additional $H^+$ in aqueous solutions

Base is a substance that donates $OH^-$ or accepts $H^+$.

**The pH Scale**

The concentration of $H^+$ is expressed as pH 

$$pH = -\log [H^+]$$

In a neutral solution at 25°C 

$$[H^+] = [OH^-] = 10^{-7}, \text{ and } pH = 7.$$ 

In an acidic solution, $[H^+]$ is greater than $[OH^-]$, and the pH is less than 7.

In a basic solution, $[H^+]$ is less than $[OH^-]$, and the pH is greater than 7.

In any aqueous solution, the product of the $H^+$ and $OH^-$ concentrations is constant at $10^{-14}$. This can be written

$$[H^+][OH^-] = 10^{-14}$$

**Buffers**

Buffers are substances that minimize changes in pH. A buffer consists of an acid - base pair that combines reversibly with hydrogen ions.

**Question:** HCl is a strong acid that dissociates completely in water: $HCl \rightarrow H^+ + Cl^-$. What is the pH of 0.001 M HCl?