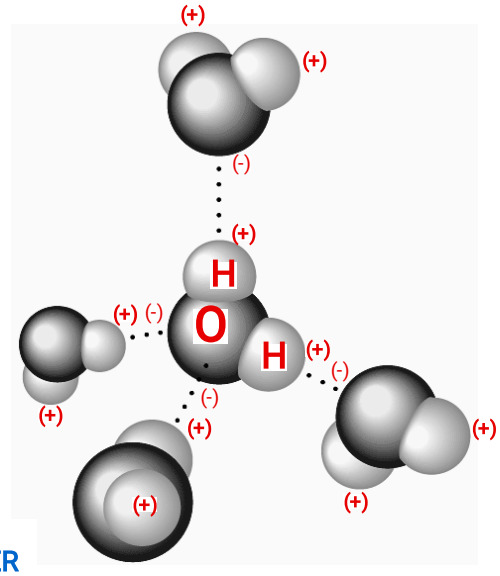
Guided Reading: Chapter 3

1. Study the water molecules at the right. On the central molecule, label oxygen (O) and hydrogen (H).



(p.41) **2.** Why is water considered a polar molecule?

Water is considered a polar molecule because opposite ends of the molecule have opposite charges due to the UNEQUAL sharing of electrons.

(p.42) **3.** Now, add + and – signs to indicate the charged regions of *each* molecule. Then label the hydrogen bonds. Explain *hydrogen bonding*. How many hydrogen bonds can a single water molecule form?

Hydrogen bonds are the INTERmolecular attractions that form between a BIGGER more electronegative oxygen and the SMALLER less electronegative hydrogen thus holding water molecules together and responsible for the may life-sustaining properties of water.

4. For each of the below listed properties of water – briefly define the property and then explain how water's polar nature and polar covalent bonds contribute to the water special property. Include an example of how this property is important to life on planet Earth.

	Property	Example
(p.42)	**Cohesion** – *(like/same)* The "sticking" together of water molecules due to the hydrogen bonds between them.	*The transport of water in plants from the roots to the leaves against the forces of gravity.*
(p.42)	**Adhesion** - *(different)* The "clinging" of water to a different substance or object.	*The "clinging" of water to the sides of the vessels in plants helps to transport of water in plants from the roots to the leaves against the forces of gravity.*
(p.42)	**Surface Tension** - The measure of how difficult it is to stretch or break the surface of a liquid due to its cohesive forces.	*Some organisms can stand, walk, or run on water without breaking the surface.*
(p.43)	**High Specific Heat** - The amount of heat (kinetic energy) that must be absorbed or lost for 1g of water to change by 1°C.	*Water ability to resist changes in temperature allows it to maintain the constant temperatures of oceans and organisms (humans).*
(p.44)	**Evaporative Cooling** - The cooling effect seen on the surface of a liquid as it evaporates.	*Evaporative cooling also contributes to the stability of temperatures in plants, animals and large bodies of water.*

(p.44) **5.** Ice floats! So what? Consider what would happen if ponds and other bodies of water accumulated ice at the bottom. Describe why this property of water is important?

Ice floats because water is less dense as a solid than a liquid and reaches it's maximum density at 4°C, If ice did accumulate from the bottom, all ponds and lakes would freeze solid killing all the organisms that inhabit them.

6. Define the following terms:

(p.45) **a.** **Solute** - the substance that is dissolved

[Solutions = SOLUTE dissolved in a SOLVENT]

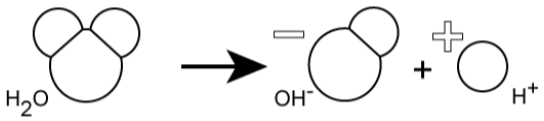
(p.45) **b.** **Solvent** - the dissolving agent of a solution

(p.45) **c.** **Aqueous solution** - any solution in which water is the SOLVENT
(water)

(p.46) **d.** **Hydrophilic** - any substance that has an affinity for water; "water-loving"
Examples: Ionic or Polar substances

(p.46) **e.** **Hydrophobic** - any substance that repels water; "water-fearing"
Examples: Non-Ionic or Nonpolar substances

(p.47) **f.** **Molarity** - the number of moles of solute per liter of solution



(p.47) **7.** Label the diagram below to demonstrate the dissociation of the water molecule and then relate this diagram to pH.

A more simplified way is to view this dissociation (separation) of water into a hydrogen ion (H+) and a hydroxide ion (OH-)

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

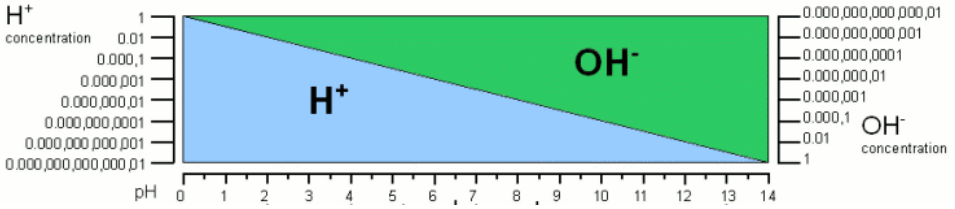
(hydrogen ion) *(hydroxide ion)*

Acidic solutions have more H^+ while basic (alkaline) solutions contain more OH^-

8. Water, which is neutral with a pH of 7, has an equal number of H+ and OH– ions. In light of the previous statement, define the terms **acid** and **base**.

(p.47) **a.** **Acid** - any substance that increases the hydrogen ion concentration (H^+) of a solution

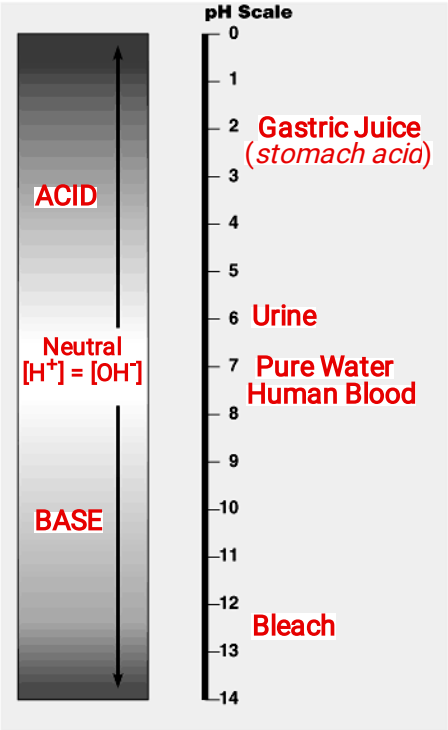
(p.47) **b.** **Base** - any substance that reduces the hydrogen ion concentration (H^+) and increases the hydroxide ions (OH^-) of a solution.



(p.49) **9.** Why are "apparently" small changes in pH so important in biology?

Small changes in pH are so important in biology because the chemical processes of the cell (*enzymes*) are very sensitive to changes in pH.

(p.41) **10.** On the pH chart below, label *neutral, acid, base*. Indicate the locations of pure water, human blood, urine, gastric juice, and bleach.



pH value	times acidity or alkalinity exceeds that of pure water (7.0)
Acidic 0	10,000,000
1	1,000,000
2	100,000
3	10,000
4	1,000
5	100
6	10
Neutral 7	1
8	10
9	100
10	1,000
11	10,000
12	100,000
13	1,000,000
Alkaline 14	10,000,000

(p.48-49) **11.** Because the pH scale is logarithmic, each numerical change represents a 10X change in ion concentration.

a. So, how many times more acidic is a pH of 3 compared to a pH of 5?

100x

b. How many times more basic is a pH of 12 compared to a pH of 8?

10000x

c. Explain difference between a pH of 8 and a pH of 12 in terms of H+ concentration.

A pH of 8 has a H+ concentration 10000x more than a solution with a pH of 12.

(p.49) **12.** What is a buffer?

A buffer is a substance that minimizes the changes in the concentration of H^+ and OH^-
or
a substance that can resist changes in pH when acids or bases are introduced

(p.49) **13.** Exercise will result in the production of CO_2, which will acidify the blood.
Explain the buffering system that minimizes blood pH changes.

Carbon dioxide in the blood combines with water to form carbonic acid (H_2CO_3)which immediately dissociates into bicarbonate ($HCO3^-$) and a hydrogen ions (H^+).

$$H_2O + CO_2 \longrightarrow H_2CO_3 \longrightarrow HCO_3^- + H^+$$

The chemical equilibrium between carbonic acid and bicarbonate act as a buffer (pH regulator) preventing the blood from becoming too acidic when CO_2 concentration increases.

(p.49) **14.** Acid precipitation is increasing. What is it and why is it important to living organisms?
(Be sure to explain its sources.)

Acid precipitation refers to rain, snow or fog that is more acidic than a pH of 5.6. It is formed when air pollution containing sulfur dioxide (SO_2) combines with water forming sulfuric acid (H_2SO_4) thus lowing the pH. This is very important to living organisms because the chemical processes (enzymes) of living organisms are very sensitive to slight changes in pH.

(p.49-50) **15.** Discuss how CO_2 emissions can affect forest ecosystems.

Another source of acid precipitation is the CO_2 released by the burning of fossil fuels - coal, oil and gas. As previously mentioned, when carbon dioxide combines with water it forming carbonic acid (H_2CO_3) which falls to the ground and upsets soil chemistry having a negative impact on forest ecosystems.