1.3) WATER SAMPLE ANALYSIS

Objective: In this laboratory exercise, you'll learn how qualities such as pH, alkalinity, hardness, conductivity, and specific gravity are interrelated and how they are distinct.
Video instructions: https://vimeo.com/121592381 and https://vimeo.com/115008135

Introduction: The chemistry of natural waters is determined by both biotic and abiotic factors. Abiotic factors are usually constant. A good example is the high pH in seawater which is attributable to the constant presence of basic salts. In sharp contrast, pH often fluctuates in freshwater ecosystems due to the (biotic) interplay between photosynthesis and respiration.

"Alkalinity" is the ability of a water sample to absorb hydrogen ions with little or no change in overall pH. This is also referred to as "acid-buffering capacity" and is determined by the concentration of weak bases that are able to absorb hydrogen ions that are added. Even though these bases are "strong" in their buffering ability, they are regarded as "weak" because they do not drastically alter pH levels on their own. Consequently, a high pH does not necessarily indicate high alkalinity (This paradox is studied in greater depth in Lab 2.3).

Hardness refers to the ability of water to form a precipitate when it is combined with soap, causing what is commonly known as "bathtub ring." This can be attributed to divalent cations such as Ca^{2+} and Mg^{2+} that interact with anions released by the soap to form salts that are insoluble. Although this trait is problematic for households, it is usually desirable in the aquatic environment because these ions are important mineral nutrients for plants and animals. Hardness is often associated with alkalinity because many of the calcium or magnesium salts responsible for hardness also contain anions that are weak bases.

Procedure A: Solution Chemistry

Evaluate the chemical parameters of different solutions and water samples using the kits provided by your instructor and organize your results into the table provided.

Procedure B: Biological oxygen Demand

1) Using screw-top plastic bottles, collect several 200-300 mL water samples from at least two different creeks, rivers, or ponds. Note the color and location from which the water was collected.

2) Upon arriving home, pass each sample through a sieve to remove any pieces of leaves or any other organic debris that could affect BOD.

3) If you are not going to evaluate your samples immediately, store them in bottles with at least 10% airspace and place them on a window sill to facilitate photosynthesis. This prevents your samples from undergoing an "algae crash" that could affect oxygen levels and turbidity. Shake each bottle for 10 seconds at least once a day to aerate the water and re-suspend any algae that are present. You can store them in this manner for at least a week.

4) Once you bring your samples to class, test them for turbidity, nitrate, and phosphate. For comparison, test a sample of distilled water.

5) Aerate your samples by shaking them for 10 seconds each.

6) Record the oxygen level of each sample. This will serve as your initial reading.

7) Squeeze each plastic bottle so that the water it contains is pushed up to the brim, then screw on the cap so there is little or no airspace. *Make sure you cap it tightly so that the air does not leak back in!* If your bottles are too rigid to be squeezed, you can pour each into a smaller plastic bottle that can be filled to the brim.

8) Store your samples in a dark drawer for about one week at room temperature.

9) After 6-7 days, slowly pour out your samples (so as to aerate them as little as possible) into the small beaker. Measure oxygen again. This will serve as your final reading.

10) Subtract your final reading from your initial reading. This will be your sample's measurement of biological oxygen demand.

Solution Chemistry of Prepared Solutions

Solution	Specific Gravity	Conduct-ivity	TDS (optional)	Alkalinity (optional)	Hardness (optional)	pH
Distilled Water						
Tap Water						
Fresh sparkling water	N/A*					
Boiled sparkling water						
Sucrose Solution						
HCO_3 Solution (optional)						
$CaCl_2$ or $MgSO_3$ Sol'n (optional)						
(optional)						
(optional)						
(optional)						

* The bubbles in this solution interfere with the measurement of specific gravity.

Solution Chemistry of Natural Waters

Water Source	Specific Gravity	Conduct-ivity	Alkalinity (optional)	pH	Phos-phate	Nitrate	Turbid-ity	BOD
SW Aquarium								N/A*
FW Aquarium								N/A*
Water sample 1								
Water sample 2								
Water sample 3								
Water sample 4								
Water sample 5								
Water sample 6								

* BOD is not evaluated in these samples because aquarium water is filtered.

Questions:

1. Which item has the highest conductivity? Is this expected? Why or why not?

2. Which item has the lowest conductivity? Is this expected? Why or why not?

3. Which item has the highest specific gravity? Is this expected? Why or why not?

4. Which item has the lowest specific gravity? Is this expected? Why or why not?

5. Is specific gravity always correlated with conductivity? Why or why not?

6. Which item has the highest pH? Is this expected? Why or why not?

7. Which item has the lowest pH? Is this expected? Why or why not?

8. Why does boiling change the pH of sparkling water?

9. Which water sample has the highest turbidity? What is responsible for this?

10. Does the natural water's location play a role in turbidity?

11. Which water sample has the highest BOD? What is responsible for this?

12. Which water sample has the lowest BOD?

13. Does turbidity play a role in high BOD? Why or why not?

14. What kind of pollution is likely to increase BOD? Explain why:

Assignment Checklist:

1. Did you answer all the questions?
2. Did you record all the data on the table?