

Multiple Variable Analysis:

Effects of varying levels of carbon dioxide on water acidification

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| Background Study--Properties of Water  Complete activities listed.  Activities do not need to be investigated sequentially.  Prior to leaving the station, make sure it has been set up for the next group. Discard trash as necessary. Rinse, wash and store or dry supplies, as necessary. | **Seawater** |
| Calculations and Mixture Preparation  Complete calculations listed.  Prepare seawater. |  |
| Guided Investigation--Determining pH using Bromothymol Blue Indicator and Spectrophotometry (multiple variable analysis)  Complete data collection.  Learn and practice spectrophotometry procedure. | Image result for bromothymol blue |

Multiple variables involving carbon dioxide (carbonic acid) levels and waters will be investigated. Tap water and seawater will be tested with exposure to varying levels of carbon dioxide resulting in carbonic acid formation and measurable differences in pH levels.

**A) Meniscus Study**

Fill each graduated cylinder (plastic and glass) with the same volume of water. Observe how the meniscus differs in each cylinder. Draw conclusions about the effects of such issues.

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| Observations: | Sketches: | Properties Involved: |

**B) Dip Study**

Dip a corner of wax paper into a vat of water. Dip a corner of paper toweling into a vat of water. Save samples. Make drawings to label dip levels and saturation points.

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| Observations: | Sketches: | Properties Involved: |

**C) Drop Study**

Fold a piece of wax paper in half. On the left, place three drops of water. On the right, place three drops of detergent water. Make observations as you move paper around. Label and save sample.

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| Observations: | Sketches: | Properties Involved: |

**D) Balloon Study**

Rub the balloon against your clothing. Turn on the faucet until a slow running stream of water is established. Bring the balloon close to the stream of water. Do NOT allow the balloon to touch the water.

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| Observations: | Sketches: | Properties Involved: |

**E) Penny Study**

Count how many drops of water fit on the head of a penny. Repeat with detergent water. Use the same dropper for each trial but conduct the water trial before the detergent water trial. Record data here and on pooled chart.

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| Observations: | Sketches: | Properties Involved: |

**F) Ice Study**

Observe the solid form of water floating on the liquid form with and without salt. Describe implications.

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| Observations: | Sketches: | Properties Involved: |

**G) Evaporation Study**

Use the wipes to rub some water on the inside of your forearm. Place your moistened arm in front of a fan, and time how long it takes your arm to dry. Repeat this with an alcohol swab. Record data here and on pooled chart.

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| Observations: | Sketches: | Properties Involved: |

**H) Slide Study**

Place water on a microscope slide and use another to create a sandwich. Dry slides after use.

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| Observations: | Sketches: | Properties Involved: |

**I) Needle Study**

Fill a beaker with water. Attempt to float a needle on the surface. What are the “tricks” to this? After it is floating, add one drop of soap to the opposite side of the beaker. Rinse needle and beaker thoroughly.

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| Observations: | Sketches: | Properties Involved: |

**J) Water and Oil Study**

Study the water and oil mixture.

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| Observations: | Sketches: | Properties Involved: |

**K) Powder Study**

Nearly fill a beaker with water. Sprinkle powder on the surface of the water. Dip a toothpick barely into the liquid soap and tap the toothpick gently into the center of the water with powder.

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| Observations: | Sketches: | Properties Involved: |

**L) Ion Study**

Watch video animation of salt in water.

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| Observations: | Sketches: | Properties Involved: |

**M) Acidification Study**

Two of the most prevalent ions in sea water are sodium and chloride. Together, they make up over 90 percent of all dissolved ions in the ocean. Sodium and Chloride are “salty.”

By some estimates, if the salt in the ocean could be removed and spread evenly over Earth’s land surface, the salt would form a layer more than 500 feet thick--about the height of a 40-story office building (National Ocean and Atmospheric Administration, US Department of Commerce). Imagine that…

The concentration of salt in seawater (referred to as salinity) is about 35 parts per thousand. Calculate the percentage of salt in seawater. Show your work.

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Check your calculation against the master copy. Make corrections as necessary.

Use your calculated measurement to mix a 200 mL solution of mock seawater for use in the lab. Again, show your work. How much salt (in grams) is necessary?

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| Sea Salt (in grams) | Water (in mL) |
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Check your calculation against the master copy. Make corrections as necessary.

Prepare seawater mock solution. Label with your name and set aside.

**Part C: Guided Investigation**

Determining pH using Bromothymol Blue Indicator and Spectrophotometry (multiple variable analysis)

Recall that Bromothymol blue is an indicator for weak acids and bases. When in basic solutions, Bromothymol blue will appear blue; when in neutral solutions, it will appear green; and when in acidic solutions, it will appear yellow. These changes can be observed visually, with litmus paper, and more precisely with a spectrophotometer. A spectrophotometer measures the absorbance or transmittance of light through a solution.

Simply breathing in a solution of Bromothymol Blue will introduce carbon dioxide from your breath into the solution. The carbon dioxide reacts with the solution to form carbonic acid, which in turn increases the acidity of the solution.

We will use various states of aerobic exercise to establish varying levels of carbon dioxide. See protocols.

Gather all spectrophotometry handouts and preview information. Watch user’s manual video.

Blanks have been prepared, labeled, and stored for water and seawater. Always return blanks to proper labeled area as blank cuvettes themselves cannot be labeled.

Procedure:

Test solutions—Use water for one test, use seawater for an additional test

Carbon Dioxide Levels—Use rested for one test, use exercised for an additional test

Conduct all possible combinations of tests.

1. Pour 30 mL of test solution in a plastic cup. Add a clean straw with a plastic lid or splash protector.

2. Add 12 drops Bromothymol blue to this solution.

3. Blow through the straw into the solution 30 seconds. Do not ingest or draw up any of the solution, only exhale/blow through the straw.

4. Pour some of this solution into a cuvette. Set correlating blank. Then, obtain spectrophotometry results with test solution. Record results of %T and A in table. At the same time, use remaining sample to test pH using test strip. Record results.

5. Discard straw, rinse cup and lid for reuse, and repeat procedure for all trials as necessary to complete all combinations.

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| Exercise Subject Protocol:  Immediately prior to your data collection, run as vigorously as possible around the science building (include stairs) for 5 minutes. Please be on the watch for doors opening and other pedestrian traffic. Run quietly as classes are in session. Have a sign indicating—ROOM 921: DATA COLLECTION ONGOING—that instructor has signed. | Resting Subject Protocol:  Immediately prior to your data collection, be at rest completely for 5 minutes. Just sit quietly—no writing, no activity, no talking. |

Additionally, we will measure dissolved blood oxygen with the use of a pulse oximeter. A pulse oximeter is used to determine levels of dissolved oxygen in blood. This measurement is considered one of the vital signs that hospitals regularly monitor.

Repeat these steps using both combinations with both variables. (This is the multivariable approach).

Remember: When comparing spectrophotometer results, you must check seawater against the seawater blank and water against the water blank.

Why water? Why seawater?

Why did we use tap water and not distilled water in our solutions?

What does this tell us about acidification of lakes? Of oceans?

How does aerobic exercise correlate to carbon emissions/burning of fossil fuels? Is it a realistic model?



