Ocean Acidity and Temperature Change (may be done without probeware.)

As carbon dioxide gas, CO2, dissolves in water, the following reaction occurs:

**CO2 + H2O  H2CO3**

H2CO3 is a weak acid. The acidity of a solution can be expressed using the pH scale, which ranges from 0 to 14. Solutions with a pH above 7 are basic, solutions with pH below 7 are acidic, and a neutral solution has a pH of 7. Carbon dioxide gas, CO2, diffuses into ocean waters. Here you will test how CO2 affects the pH of sea water. The source of CO2 will be your breath. Additionally, you will test the effect of CO2 when added to ocean water of various temperatures.



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|  | ring stand |
| LabQuest | utility clamp |
| \*Vernier pH sensor | straw |
| \*Vernier temperature sensor | graduated cylinder |
| beakers | water bath |
| ocean water |

MATERIALS

\*ph paper may be used at 10-15 second intervals and any thermometer may be used to periodically check the temperature.

PROCEDURE

Part I: pH of ocean water-establishing a baseline (control)

**NOTE:** Before each use of the pH sensor rinse the tip of the sensor thoroughly with distilled water.

**Important:** Do not let the pH sensor dry out. Keep it in a 250 mL beaker with about 100 mL of distilled or tap water when not in use. The tip of the sensor is made of glass—it is fragile. Handle with care!

* Turn on your LabQuest. (Review your ‘QuickStart’ booklet if needed.)
* Connect the temperature sensor to your LabQuest in CH1. Connect the pH sensor in

CH 2. You should see the current temperature and pH displayed on the screen.

* Wash a 250 mL beaker with tap water and dry it with a paper towel. **NOTE**: All

glassware must be clean.

* Use a graduated cylinder to measure 100 mL cold (around 8ºC) ocean water. Place

into the clean beaker. (This is the usual temperature of Northern Pacific or Atlantic

surface water.)

**IMPORTANT NOTE:** Each time you collect data, wash and dry your beaker and use 100 mL new ocean water. Collect data 3 times for each set of conditions (3 trials, minimum). If you are getting consistent results go on to your next set of conditions. If not, repeat until you do get consistent results. (Hint: Are you maintaining your initial temperature by using a water bath? Cool or warm your water sample by placing a small beaker in a larger beaker of ice-cooled or hotter tap water to make a water bath. Try to stay within 3-4ºC variation.)

* Using a ring-stand and utility clamps, secure the pH Sensor in the beaker as shown in

Figure 1.

* Secure the temperature probe in a similar manner but don’t let it touch the beaker or

pH sensor (it should only be touching the liquid you want the temperature for).

* Record the temperature of the water in the title of the data table. (Tables for your

use are attached.)

* Record the pH value displayed on the screen as the initial pH (time 0) in a data

table.

* Tap ‘Duration’. When the new screen comes up, change the duration to 90s and tap

‘OK’. You will go back to the Meter screen.

* Tap on the ‘Graph’ icon. At this screen, tap or press the ‘Go’ arrow to begin data

collection.

* Data will stop collecting at 90s. To examine the data pairs on the displayed graph, tap

any data point. As you tap each data point, the pH and time values are displayed to

the right of the graph. **Or**, you can tap on the ‘Data Table’ icon to scroll through all of

the data. Record the pH value at 10, 20, 30, 40, 50, 60, 70, 80, and 90 seconds in

your data table.

* Tap the ‘File Cabinet’ icon to begin your next trial. “Run 1” will now say “Run 2” and a

new graph will appear.

* Repeat data collection for your control at least 3 ‘Runs’. To compare results of all

trials, tap the ‘Run’ icon and select “All Runs”. Be sure to notice the scale (axes) of

your graph as it can be misleading. You can also tap the ‘Data Table’ icon and

examine the data points for all trials.

* Save your “Control” data. Title it to describe the conditions and add your name or

initials and the date. Example: ControlDC7-23.

* Tap ‘FILE’ (back at your graph screen). Select ‘New’; go on to Part II.

**Part II: CO2 and ocean water-add a variable**

**NOTE:** Set up your experiment using the same protocol. This time add CO2.

* Place a clean straw into the distilled water. Start data collection. Take a normal

breath, then evenly blow into the water for about 5-6 seconds. Repeat, for a total of

90 seconds. \* You can release the straw to breathe in. (Be careful to breathe in

through your nose if your mouth is on the straw!)

* Save your set of 3 trials (minimum) for part II.
* **Part III: CO2 and Temperature** \* See below for temperature conversions.
* Start with ocean water at 8-14 °C.
* Repeat using a sample of ocean water you warm up 1-3°C.
* Repeat using a sample of ocean water you warm up 4-8°C.
* Repeat using a sample of ocean water you warm up to 27-31°C (tropical waters).

\*<http://www.nodc.noaa.gov/dsdt/cwtg/egof_tmap.html> move the map around and click

on any ‘balloon’ to see the current temperature of the surface water.

* Save your set of 3 trials for each of the conditions tested in part III before going on to

the next condition.

**\*Reminder: always clean the beaker and change out ocean water between trials.**

ANALYSIS:

* Calculate the change in pH (ΔpH) for the water in each experiment.
* Display data from your most consistent run in each part, graphically. Put the five

lines on the same graph. What does your graphical analysis indicate?

**CONCLUSION:**

* What generalization can you make about temperature and ocean acidification?

Support your assertion by using data you collected.

* What would your next question be?

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| http://www.greenigsociety.org/gif/fahcelchart.gif |

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| **Degrees Fahrenheit (°F)** | **Degrees Celsius (°C)** |
| 212 | 100.0 |
| 100 | 37.8 |
| 90 | 32.2 |
| 85 | 29.4 |
| 80 | 26.7 |
| 70 | 21.1 |
| 60 | 15.6 |
| 50 | 10.0 |
| 40 | 4.4 |
| 32 | 0.0 |
| 20 | -6.7 |
| 10 | -12.2 |
| 0 | -17.8 |

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| **How To Convert Temperatures** | |
| **Fahrenheit to Celsius** | **Celsius to Fahrenheit** |
| 1. Subtract 32 from degrees Fahrenheit 2. Multiply by 5 3. Divide by 9 | 1. Multiply degrees Celcius by 9 2. Divide by 5 3. Add 32 |

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| **No CO2 added to ocean water at \_\_\_\_\_\_\_°C (CONTROL)** | | | | | | | | | | | |
| Time (s) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | ΔpH |
| pH |  |  |  |  |  |  |  |  |  |  |  |

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