Ocean Acidity and Salinity Change

 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 salinities.

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|  | ring stand |
| LabQuest  | utility clamp |
| Vernier pH sensor | straw |
| Vernier temperature sensor | graduated cylinder |
| beakers  | water bath  |
| ocean water |
| Instant Ocean® (aquarium sea salts) |

MATERIALS



PROCEDURE

Part I: CO2 and 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.

* Put 100 mL cold (between 8ºC and 14 ºC) ocean water of 3.2% salinity into this clean

 beaker.

* **IMPORTANT NOTE:** Each time you collect data, wash and dry your beaker and use 100 mL new, 3.2% 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 or pan of ice-cooled or hotter tap water to make a water bath.)
* 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. You can also tap the ‘DataTable’ 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 sample. 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). (Try to keep the temperature constant.)

**Part III: CO2 and salinity** \* Make sure the beaker is clean. (Try to keep the temperature constant with no more than 2-3ºC change.)

* Average surface salinity in the world’s oceans is 3.31-3.72%. Salinity is often

 described as PPT (parts per thousand) which can easily be converted to %. 32PPT is

 3.2%. To increase the salinity by 0.1% add 1.01g sea salts to each 100mL original,

 cold, ocean water. To decrease you will need to make dilutions with distilled water.

 (Always describe your procedures and show your calculations!) Your 3.2% salinity

 ocean water has a specific gravity of 1.024. You may find using a hydrometer helpful.

* Make 3 more, different, salinities to test by adding Instant Ocean®, or distilled water,

 in the appropriate amounts. If you are using a hydrometer to determine specific

 gravity, this is a useful website: <http://www.saltyzoo.com/SaltyCalcs/SgPptConv.php>

* Save your set of 3 trials for each of the salinities tested.

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?

* Extrapolate to determine the pH for sample at 1.5% saline above your highest

 sample and 1.5% below your lowest sample.

* Interpolate to determine the pH for a point between each of the samples you made

 (you should have 2 pHs interpolated since you made 3 samples).

**CONCLUSION:**

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

 Support your assertion by using data you collected.

* Address any difficulties or concerns you had about controlling variables. Are your experiments valid? How do you know?
* What would your next question be?

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

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| **Adding CO2 from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ‘s breath to ocean water at 3% salinity and \_\_\_\_\_\_\_°C**  |
| Time (s) |  0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | ΔpH |
| pH |  |  |  |  |  |  |  |  |  |  |  |

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