Water Resources - Experiment #1
1.101 Sophomore Design - Fall 2006
Measuring pH

Calibration of the glass electrode to measure the pH of water.

Because this project is about *pH* control, it will be necessary to measure *pH*, both to test the performance of the treatment system that you design and build and to develop *design curves* that will help in the design process. We will use a "glass electrode" to measure pH. An appendix to this brief description of lab procedure explains in more detail the function of this instrument. (See also the two page article "The Glass pH Electrode" by Petr Vanysek posted on our Stellar site).

The glass electrode, when the tip is submerged in water, produces a voltage linearly related to the pH of the water, i.e.,

$$V = (slope) \cdot pH + V_{offset}$$

where V_{offset} is a constant for the particular device you have in hand.

Supplied with three standard calibration solutions (pH buffers) at pH 4, 7, and 10, you can deduce measures of the values of the two parameters, the *slope* and V_{offset}, by recording the three voltages, *V*, seen when the electrode is submerged into each of these three solutions and fitting a straight line to a plot of the Voltage-pH pairs. (Two measurements - say at pH 4 and pH 10 is all one needs - but take the three measurements and compare the straight line fit with a two-point, direct determination of the slope and intercept).

To obtain a good measure of the glass electrode output signal, V, requires signal conditioning. The electrode simply can not deliver the amount of current required to operate most data readout devices - a digital voltmeter in our case. The circuit includes an electronic device - an operational amplifier or "op-amp" for short - whose input impedance is much higher than the electrode's and whose output is proportional to the op-amp's input. The op-amp, powered externally, is capable of delivering adequate current to a data readout device. See the Appendix for a detailed description of this circuit. Your lab instructor will help you make the appropriate connections and explain how the circuit functions.

Record your voltage measurements and do the calculations of the *slope* and V_{offset} in your lab notebook. Summarize the results of your calculation of the *slope* and V_{offset} on the next page. You will hand in this one page at the end of lab. Include any observations you find of significance. In particular, how many significant figures can you claim? What uncertainty, expressed as +/-%, would you associate with each parameter?

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Summary of calibration results:

Instrument ID: _____

$$V = - (\qquad) \cdot pH + (\qquad)$$

(Note the negative sign).

Slope uncertainty is +/-_____ %   and V_{offset} uncertainty is +/- _____%

Comments:

Using the calibrated pH sensor to measure the acidity of three water samples.

Measure the pH of the tap water from a laboratory sink (Cambridge Water Supply)

pH = _____ =/-_____%

Measure the pH of the tap water from Lexington residence (MWRA Supply)

pH = _____ =/-_____%

Measure the pH of the water sample from the well of a residence on Cape Cod. (Well Water)

pH = _____ =/-_____ %

Go back and re-calibrate you pH sensor. How close is it to your first calibration?

They differ by _____ %.

Comments:

NAME: _____   DATE: _____

LAB PARTENERS: _____, _____, _____.