Section 1 – Salinity Circuit

1.) What factors (other than salinity) might affect your resistances?

Size of the probe: the smaller the probe, the higher the resistance because reduced surface area limits the amount of current that can flow

Distance of the probes: the farther the probes, the greater the resistance

Salinity changes the resistivity, not resistance, of water. The resistance that is measured is a factor of resistivity, length, and surface area.

2.) Are you able to get stable readings? Why?

No, the resistance should increase over time. The current generated in the water will cause water particles to decompose and plate out on the electrodes.

3.) How can you make sure that you get stable output voltages if the multimeter was giving you changing resistances?

They can input an AC voltage. Because there is no constant directional current flow from one electrode to another, the ions will be suspended between the electrodes and not plate out.

4.) Calibrate your circuit using different known salinities.

Section 2 – Turbidity Circuit

1.) Considering this, what type of emitter and light sensor (photodiode) should your turbidity meter use?

They should use an infrared emitter and photodiodes that can measure that wavelength of infrared light.

2.) Derive the equation for the gain of the circuit (ignoring the capacitor). What are its units? Why is it called a transimpedance amplifier? What value of feedback resistor should you use? Can you use the data sheet to help you decide? Does the Light Current versus Irradiance plot help? Can you use empiricism when all else fails?

Vout = -Iin x Rf

It’s called transimpedance because it using a resistor to convert current to voltage?

Use datasheet (specifically Light Current vs Irradiance) to estimate current output, which will help us determine appropriate Rf.

3.) Check the output of the transimpedance amplifier on the scope. Is it working properly? How would you know?

We can approximate ambient light intensity and compare the actual Vout to the expected Vout.

4.) Create solutions of different turbidities to calibrate your meter.

I put droplets of milk into water because milk is pretty turbid so you can get a wide range of turbidity values by diluting it. Also, it homogenizes in water.

5.) Determine the calibration curve that relates turbidity to the ratio of your transmittance and 90-degree reflection voltages.

The deviations are probably due to slight positioning changes of my emitter and photodiodes.

Section 3 – pH Circuit

1.) What results do you get? Are they what you expect? (directly connect pH probe to amplifier)

The output voltage should be basically zero for all pH. This is because the pH probe has a large resistance (on the order of millions of ohms [1]) due to current trying to flow between the electrodes through a glass membrane. The probe’s resistance and Rin are in series so the gain becomes essentially zero.

2.) Do your results match your expectations? (connect follower circuit to amplifier)

They should now see that the amplified voltage changes with pH, but it should not be (probe’s voltage) x gain. If they measure the output from the follower circuit, they will see that it is higher than the probe’s voltage. This is because of the probe’s large resistance. A small bias current through the probe can create a large voltage drop. The amplifier circuit is amplifying the voltage from the follower circuit, not the probe.

3.) Determine the calibration curve that relates pH to voltage.

4.) Why do you think using a buffer was important in this situation?

The follower circuit was important because it created a buffer between the probe’s large resistance and the amplifier.

Source:

[1] http://www.allaboutcircuits.com/textbook/semiconductors/chpt-8/op-amp-practical-considerations/