The Effects of Different Core Conductive Materials on the Performance of ISEs

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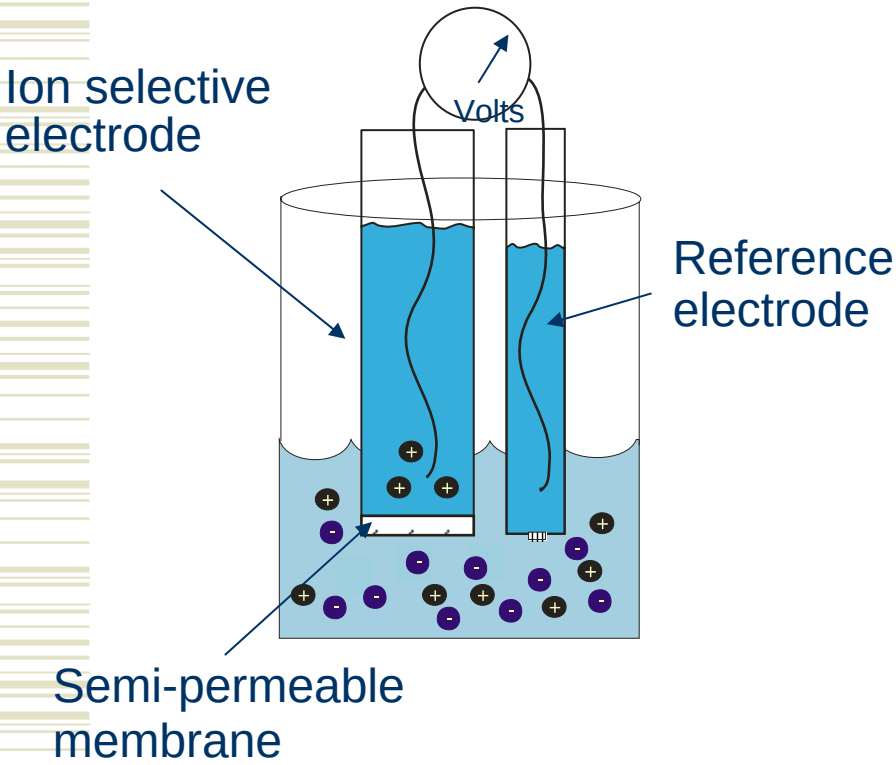
Applications

- Detection of activity of NO_3 and NO_2 in meat preservative
- Detection of activity of fluoride in dental and skeletal studies
- Detection of pollutants in fish tanks/ponds

Objective

To find the ideal construction of an Ion Selective Electrode that will function accurately in ocean water and give consistent results for a long duration

Background and Theory



- Selective membrane - permits passage of 1 ion
- Placed in solution with a reference electrode
- Voltage difference built up between two electrodes as ions flow through membrane

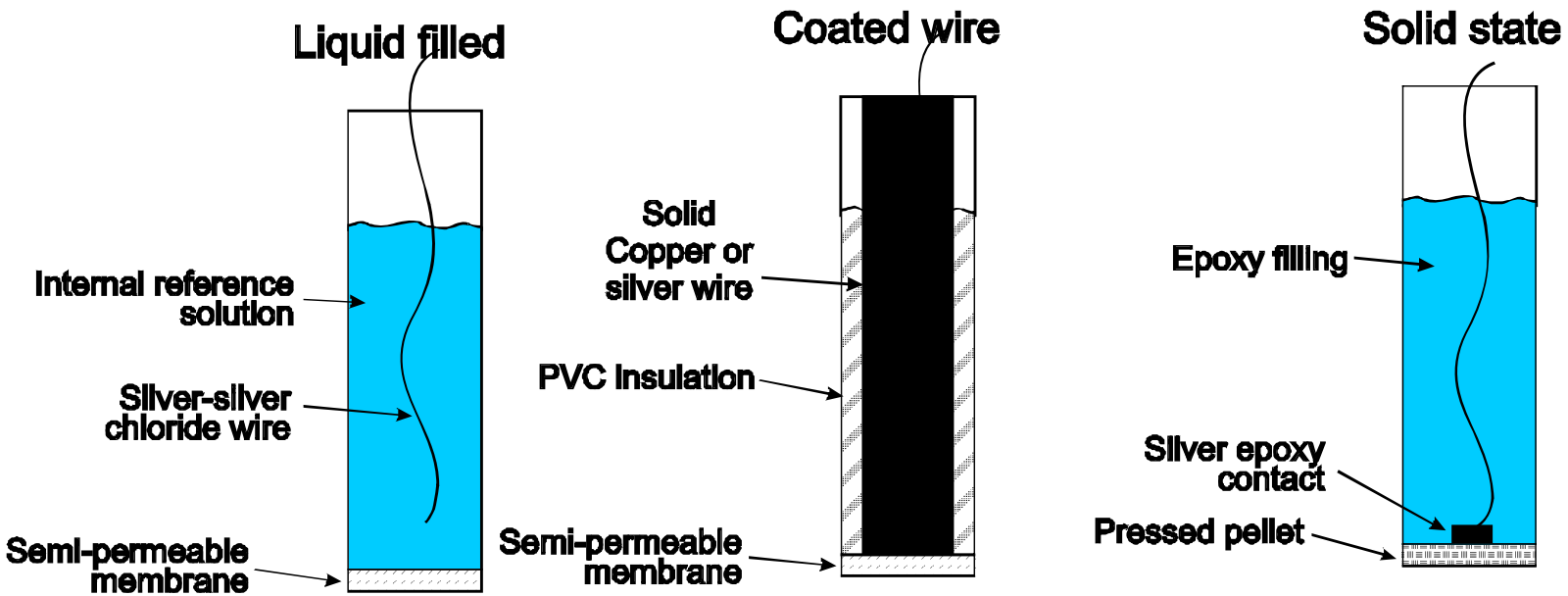
Background and Theory Cont.

- Relation between the voltage difference and the activity of the ion: Nernst Equation

$$E = E_0 + \frac{59.16}{n} \cdot \log A$$

E = voltage difference
E_0 = constant involving construction of ISE
R = gas constant (8.314 J/K·mol)
T = Temperature (K)
n = charge of ion
F = Faraday's constant (96484.6 C/mol)
A = activity of solution

Types of Ion Selective Electrodes



pH Electrodes

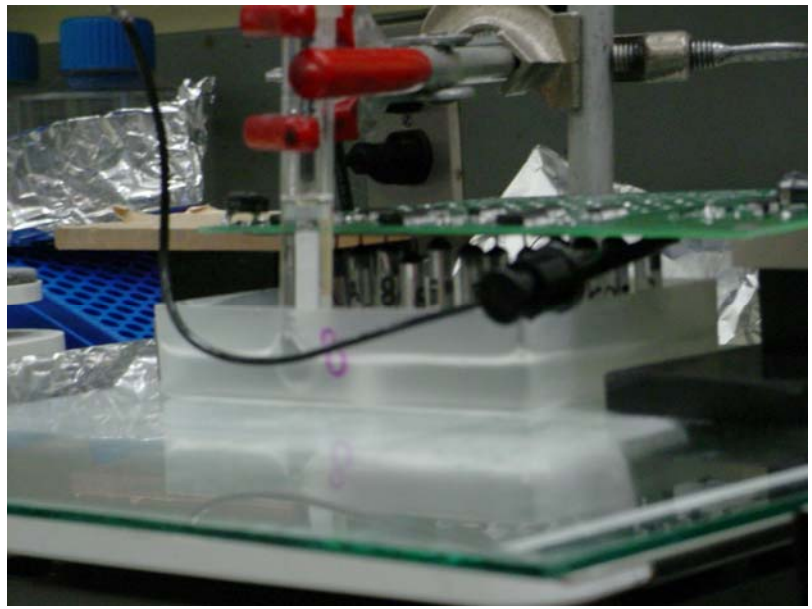
- Ion Selective Electrode that is selective to hydrogen cations
- More selective than other ISEs (others will experience greater ionic interference)
- Easiest to test: pH probes available to compare against

Experimental Electrodes

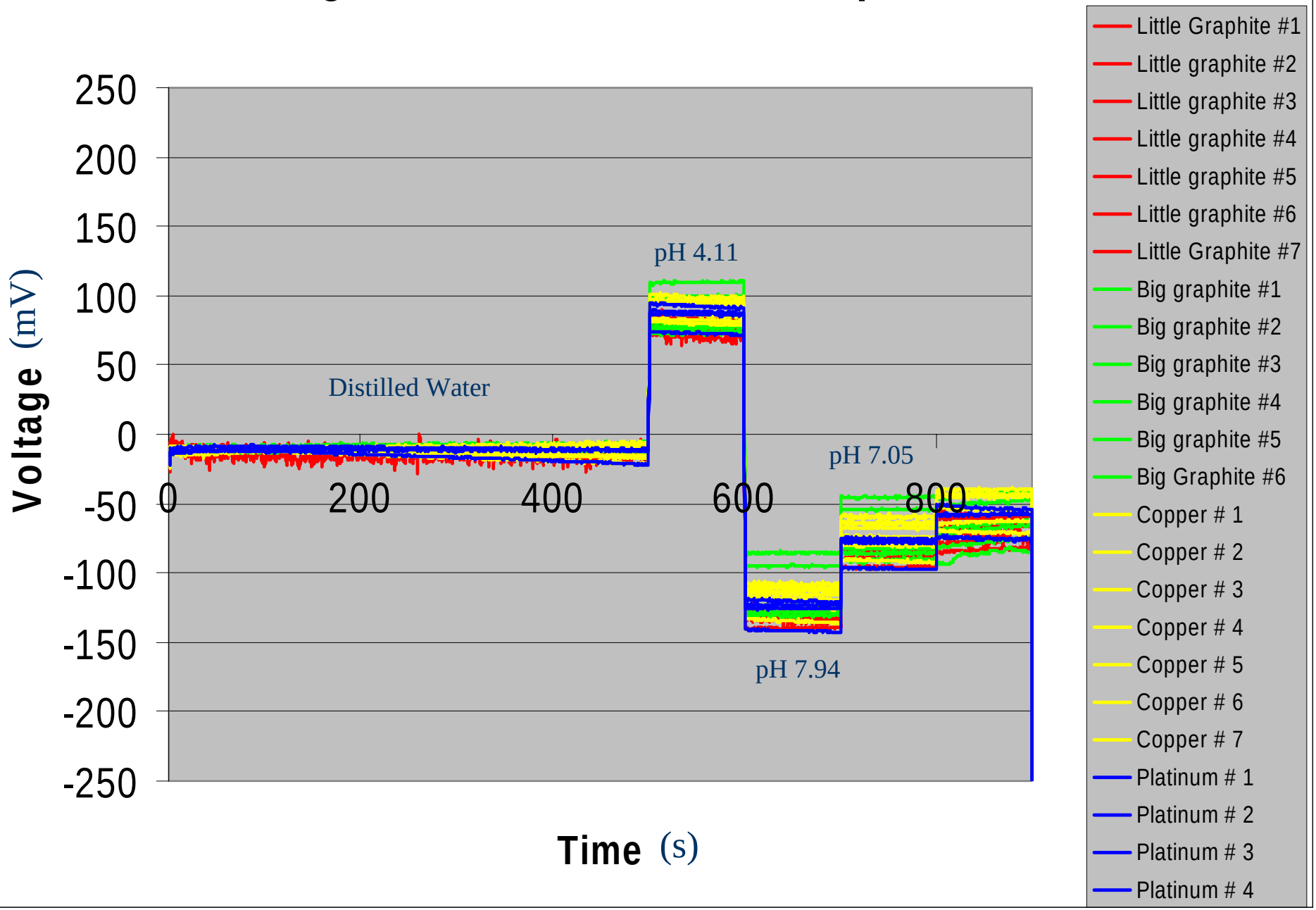
- pH electrodes used
- Variance among the electrodes: 7 core conductive materials
- 3 storage conditions: artificial sea water, distilled water, & exposed to air

Testing the Electrodes

- Run with a commercial reference electrode
- Placed in three different phosphate buffer solutions (low pH, high pH, middle pH)
- Voltage difference measured and recorded by a computer program



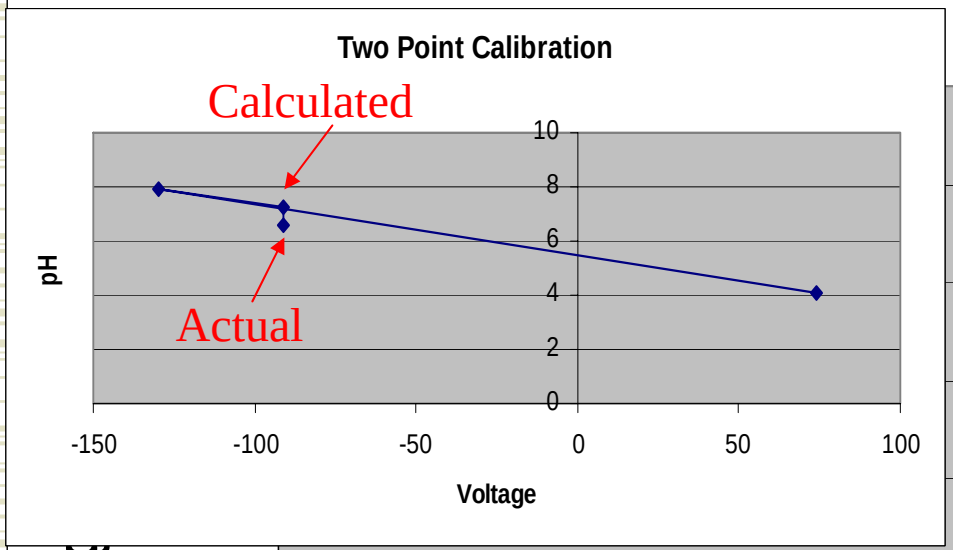
Voltage Difference in Different pH Buffers



Evaluating the Electrodes: Two Point Calibration

- Data points from low pH and high pH buffer used to construct a line
- Based on voltage reading from middle buffer, pH of middle is calculated using formula from line
- Calculated pH is compared to actual pH

Voltage Difference in Different pH Buffers



Voltag

0
-50
-100
-150
-200
-250
0
200
400
600
800

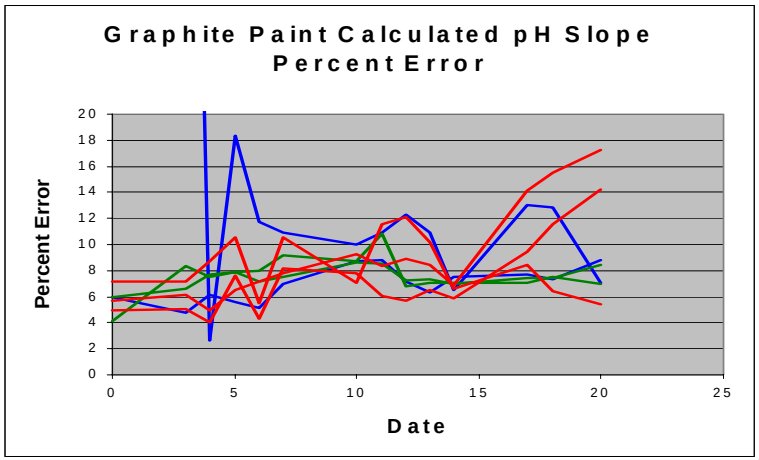
Time

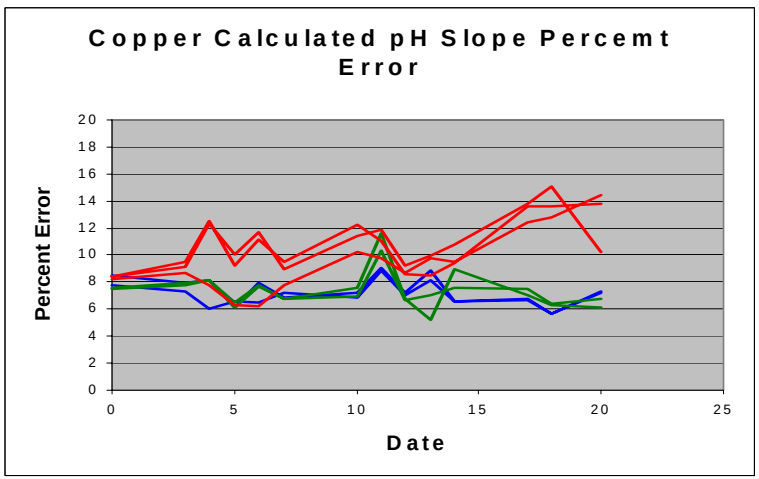
- Little Graphite #1
- Little graphite #2
- Little graphite #3
- Little graphite #4
- Little graphite #5
- Little graphite #6
- Little Graphite #7
- Big graphite #1
- Big graphite #2
- Big graphite #3
- Big graphite #4
- Big graphite #5
- Big Graphite #6
- Copper # 1
- Copper # 2
- Copper # 3
- Copper # 4
- Copper # 5
- Copper # 6
- Copper # 7
- Platinum # 1
- Platinum # 2
- Platinum # 3
- Platinum # 4

Categories of Evaluation

- Percent Error of 2 point calibration
- Percent Error of slope (compared to ideal)
- Stability of 2 point calibration
- Stability of slope
- Stability of intercept
- Stability of initial voltage

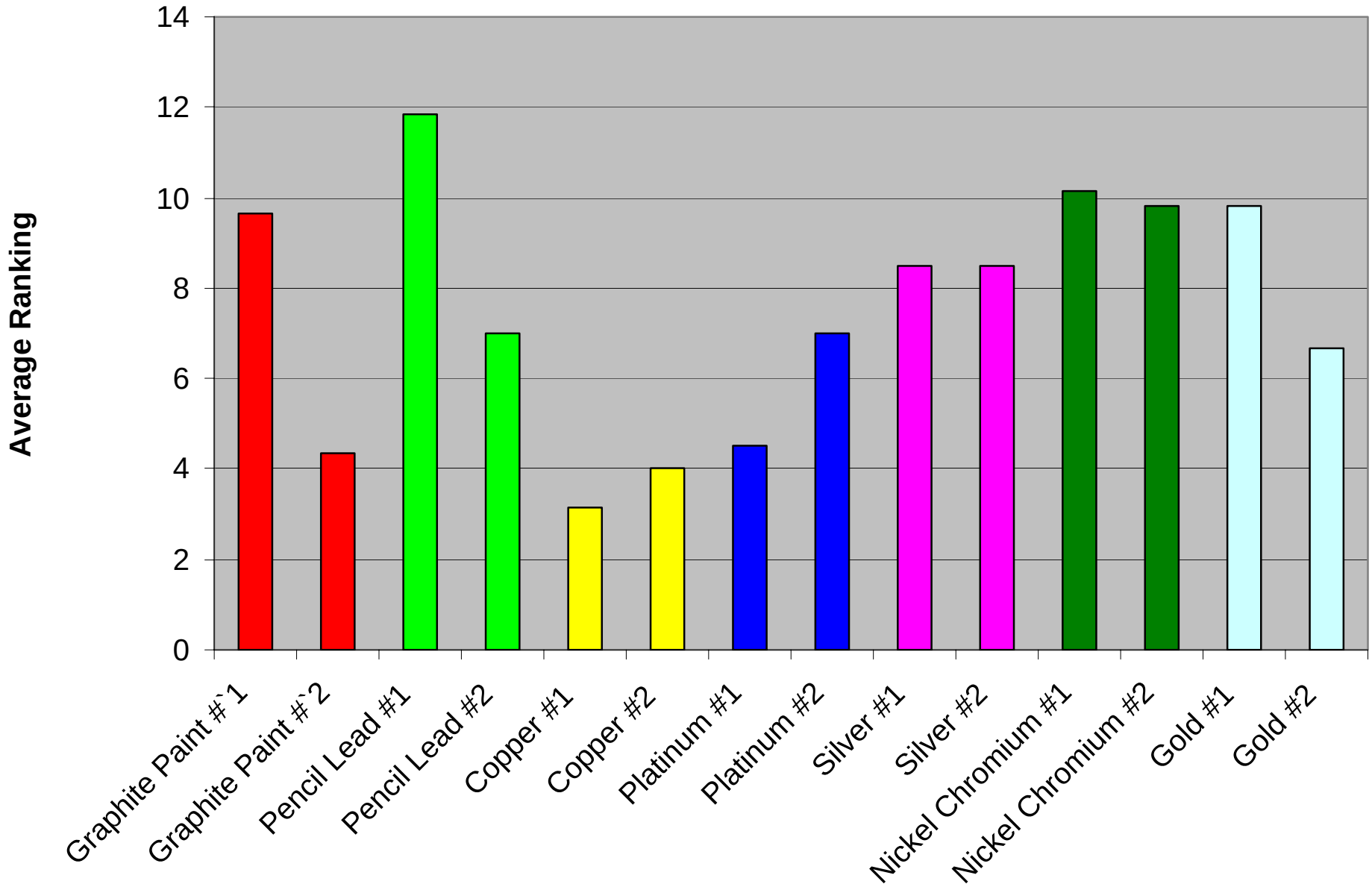
Ranking System



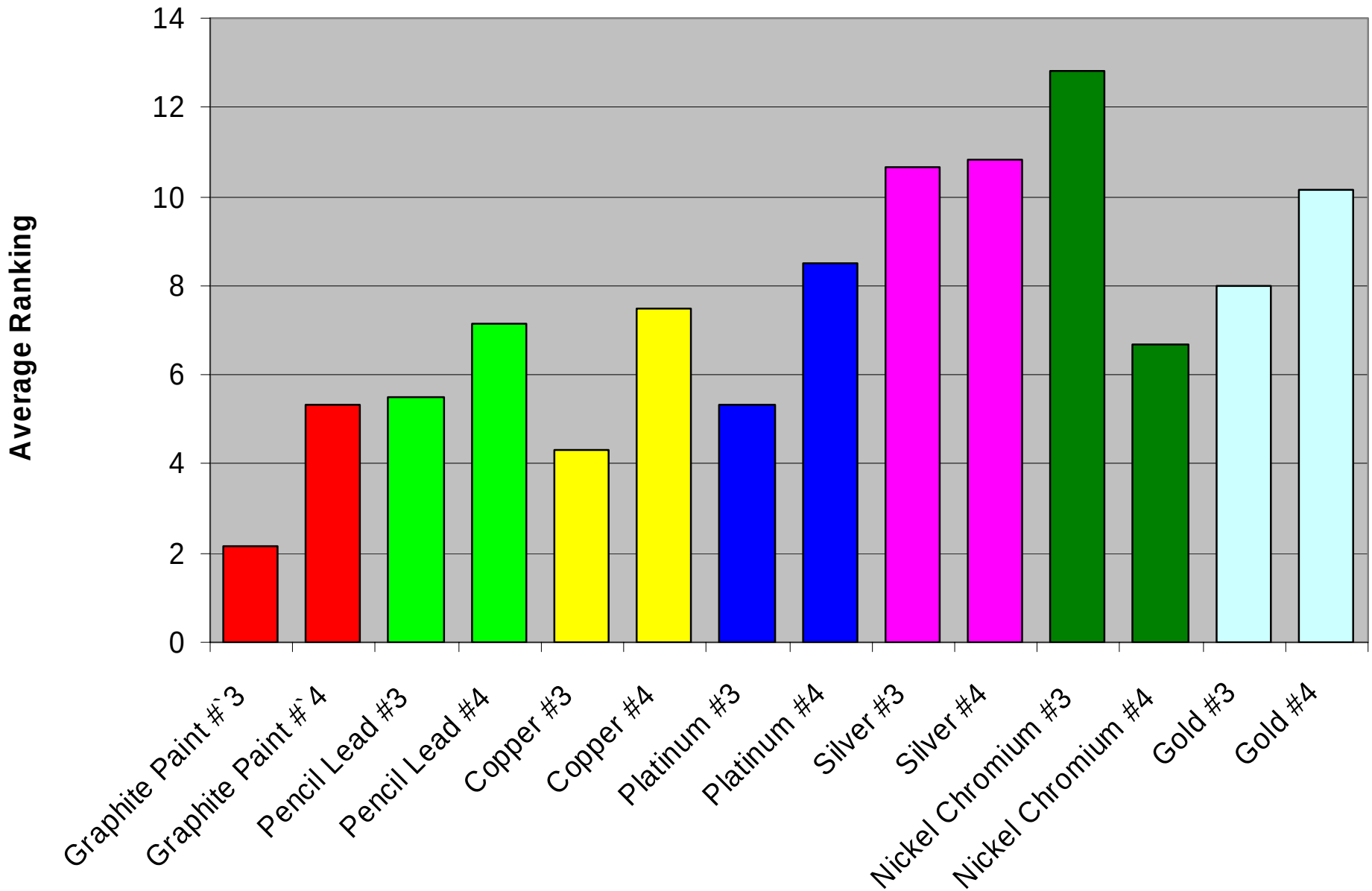


- Data collected too difficult to visually interpret
- In each evaluation category, a rank given to each group of electrodes
- Ranks were added and graphs were made (ordinal system)

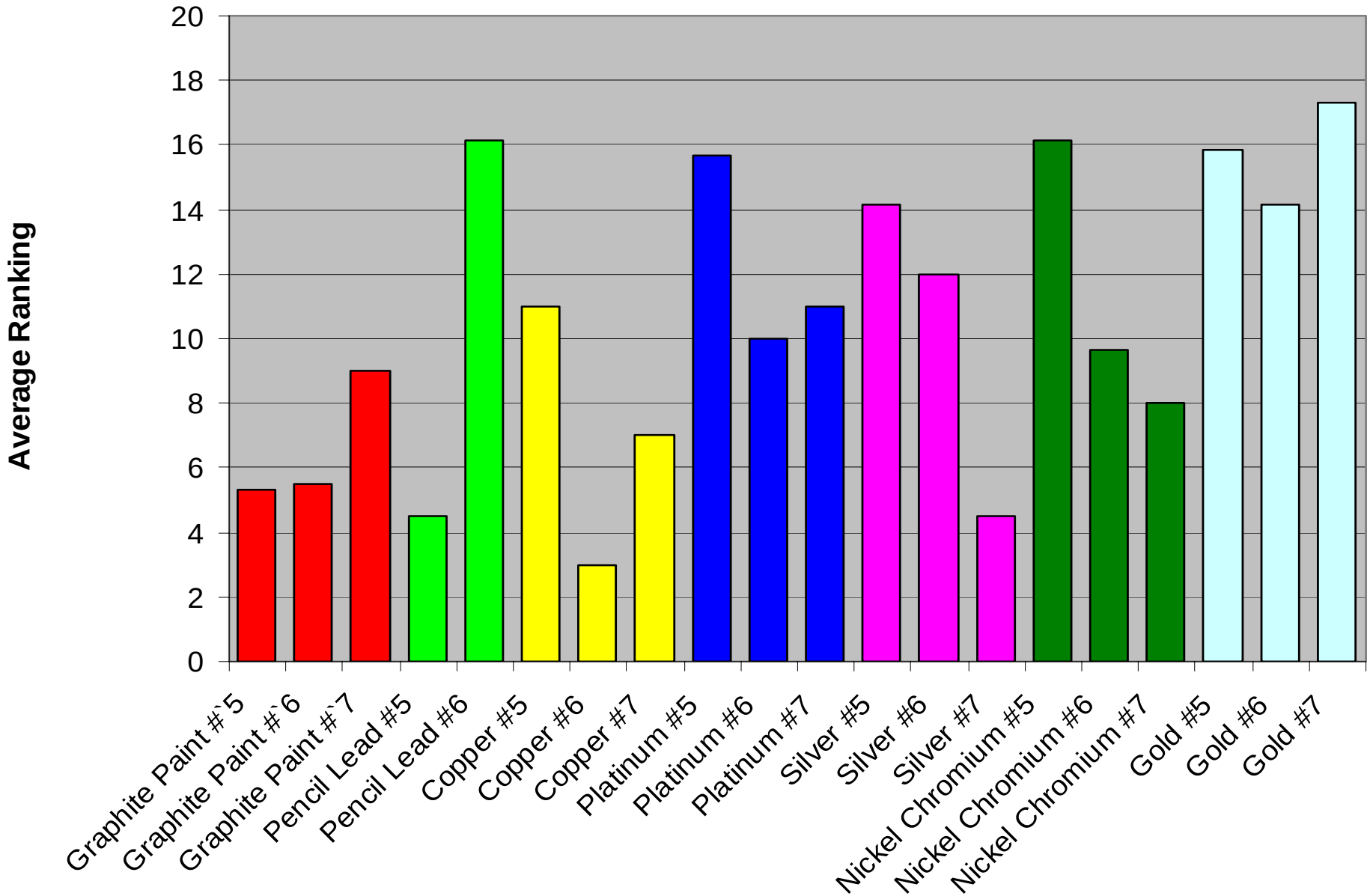
Sea Water Electrodes



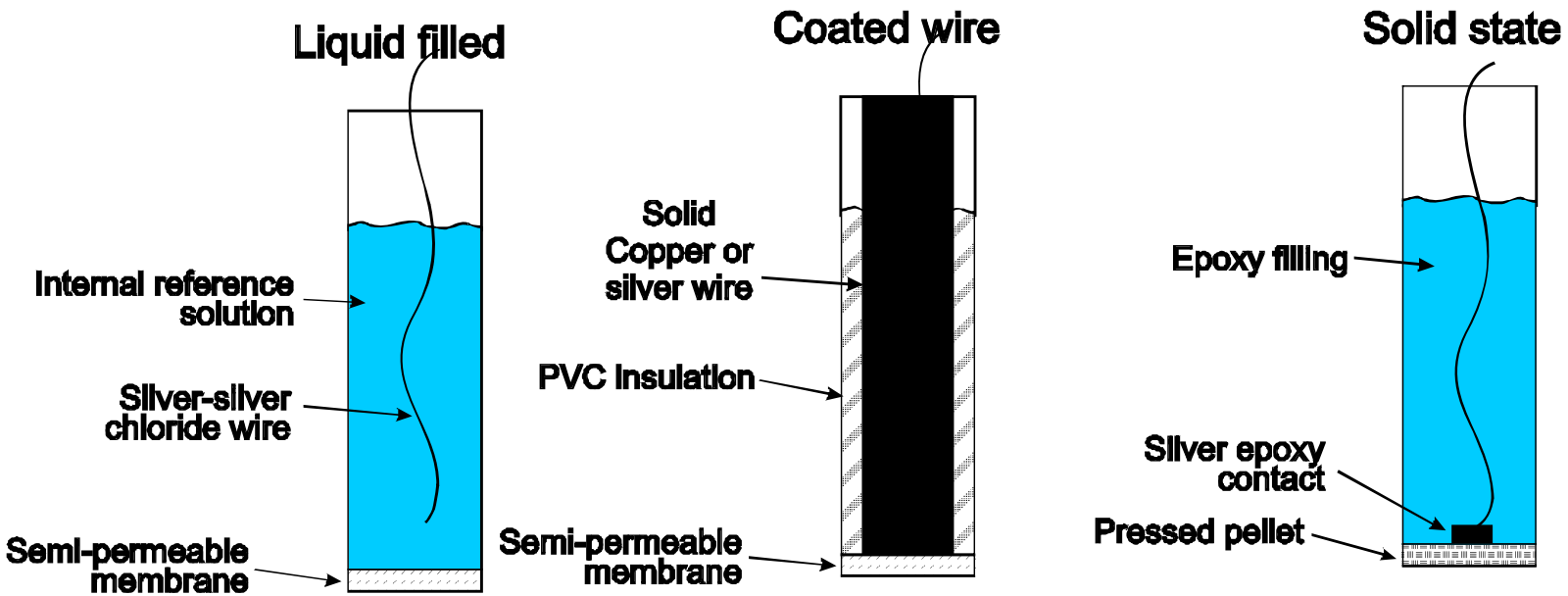
Distilled Water Electrodes



Air Electrodes



Types of Ion Selective Electrodes



Conclusions

- In oceanic environment, the electrodes with copper as conductive material seem to have worked well.
- In distilled water, the electrodes with graphite as conductive material seem to have worked well.

Acknowledgements

We would like to thank Dr. David Kidwell and Matt Garber

The End

Thank you very much for listening to our presentation

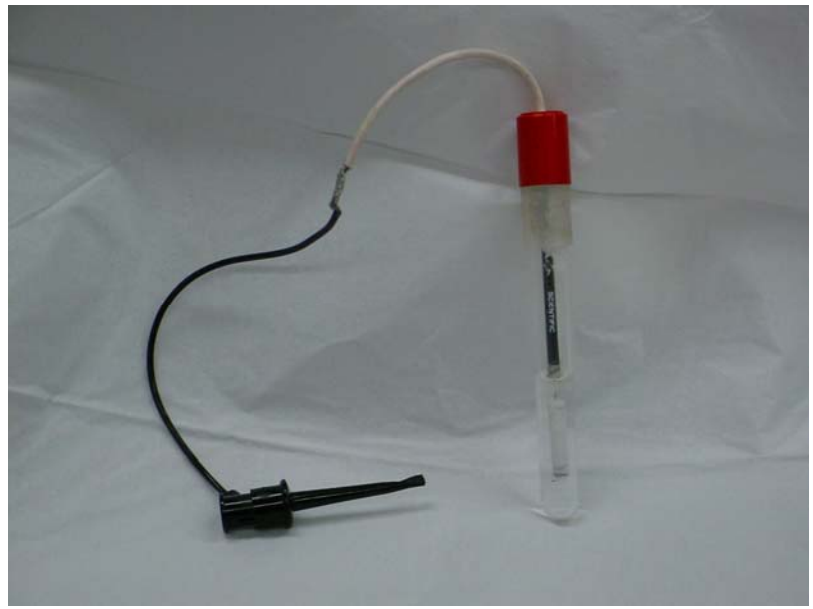
Questions?

Artificial Sea Water

MOLAR	SALT	G/LITER
0.425	sodium chloride	24.6
0.009	potassium chloride	0.67
0.0093	calcium chloride * 2H2O	1.36
0.0255	magnesium sulfate * 7H2O	6.29
0.023	magnesium chloride * 6H2O	4.66
0.002	sodium bicarbonate	0.18

Reference Electrode

- Purpose – act as a control to compare ISE to
- Must provide stable voltage regardless of solution it is placed in
- Membrane limits number, but not variety of ions
- Inner Filling Solution: concentrated to ensure little change in voltage reading



Evaluating the Electrodes: Nernstian Slope

- 2.303 RT/nF = slope = 59.16 (at room temperature)
- Data points from low pH and high pH buffers used to calculate a slope
- Calculated slope compared to ideal slope

Background and Theory

- Ion Selective Electrodes are tools to measure activity of a particular ion in solution
- Selective membrane - permits passage of 1 ion
- Placed in solution with a reference electrode
- Voltage difference built up between two electrodes as ions flow through membrane