Solution Concentrations

Goals

- ✓ Create solutions of different concentrations
- ✓ Use solutions to run a salt water battery
- ✓ Make calculations based on solution data

Background

Combining two substances doesn't have to result in a chemical reaction. It's possible to mix substances and have them form a mixture instead of a compound. Mixtures are classified based on how the substances interact when mixed together.

Heterogeneous mixtures still have different parts visible (like if you shake up oil and vinegar salad dressing) while homogeneous mixtures appear to be the same throughout (like air, which is a mixture of nitrogen, oxygen, carbon dioxide, and trace gases).

Solutions are a special type of homogeneous mixture where the particles of the substance being dissolved are so small that they can't be separated from the mixture by straining or centrifuging. Salt in water is a perfect example: once the salt has dissolved in the water, it can't be removed unless the water is evaporated.

Dissolved salt splits into sodium (Na^+) and chloride (Cl^-) ions. The presence of these ions in the water makes it easier for an electric current to flow. This allows us to generate electricity by pumping electrons from the magnesium anode to the cathode (which is actually the air) through the wires, just like a battery. If you don't remember what anodes and cathodes are, read more about electrodes in Introduction to Batteries.

The concentration of a solution can be expressed as a percentage ratio (mass of solute/volume of solvent) or as a molar ratio such as molarity (moles of solute/volume of solvent) or molality (moles of solute/mass of solvent).

During this activity, you will use a solution of salt in water to run a battery and generate an electric current.

Procedure

1. Look at the two parts of the battery and how they fit one inside the other. Does it matter which way you put one inside the other? How will you get them apart once you put them together?

2. The large flat piece with the blue top is the anode for our experiment. Electrons will be flowing out from the anode into a wire once you start the battery. Where would you attach a wire on the anode? What color of wire do you think you should you use?

3. Measure out 15 mL of salt water using the graduated cylinder and use the syringe to transfer it to the bottom part of the battery. Why do you think we don't fill it up all the way?

4. Take your anode and clip it into the bottom part of the battery. Where should you put wires to let electrons start flowing through your fuel cell?

5. You have two red wires, but only one needs to connect the battery to the fan motor. Where would you put the other red wire?

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6. Attach the black and one red wire to the fan. Attach the other red wire to two red sockets on the front and back sides of the anode. This should start the fan running. Write down anything you observe in the Observations section below.

Observations

Experimentation

1. Prepare solutions of salt water according to the following concentrations. Record how much salt you used in each concentration below:

Concentration:	g NaCL:	mL H2O:
4%	1	25mL
8%	2	25mL
12%	3	25mL
16%	4	25mL
20%	5	25mL

2. Using the different concentrations of salt water solution, use the battery to power the motor as in the Procedure section. Observe what happens each time and record your results below. Be sure to rinse out the salt water from the battery after each trial.

Concentration:	Observations:
4%	
8%	
12%	
16%	
20%	

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3. Using salt water of different temperature, run the battery like you did in the Procedure section, using the same concentration each time. Write your observations below.

Temperature (°C):	Observations:

Measurement

For this section, you will need a multimeter or the Horizon Renewable Energy Monitor. For an introduction to using a multimeter, click here.

1. Measure the current in Amps and the voltage in Volts while running the battery at different concentrations of salt. Record your answers below:

Concentration:	Current (A):	Voltage (V):
4%		
8%		
12%		
16%		
20%		

2. Voltage is equal to the current multiplied by the resistance (V = IR), so according to your data what is the resistance of the fan motor?

Resistance: ____________ Ω

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3. Measure the current in Amps and the voltage in Volts while running the battery with different temperatures of salt water. Record your answers below:

Temperature (°C):	Current (A):	Voltage (V):

4. Construct an explanation of what you observed as you tested salt water solutions of different temperatures.

Analysis

1. Make a scientific claim about what you observed while running your battery.

2. What evidence do you have to back up your scientific claim?

3. What reasoning did you use to support your claim?

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4. Design an experiment that would determine the volume of salt water solution that would produce the most electric current. Describe your experiment below:

Conclusions

1. Express the concentrations of salt water solution you measured as molar and molal solutions:

Concentration:	Molarity (mol/L):	Molality (mol/kg):
4%		
8%		
12%		
16%		
20%		

2. Based on your observations, what is the relationship between the concentration of the salt water solution and the amount of electricity generated by the battery?

3. Based on your observations, what is the relationship between the temperature of the salt water solution and the amount of electricity generated by the battery?