Monica Bruckner

Introduction to Water Chemistry (pH and EC)

Grade Level	4th, but can be adapted to higher levels
Subject Areas	Geoscience, hydrology, water chemistry, water quality
Skills	Experimentation using pH strips and an EC meter, a thermometer, and measuring using beakers; observation; group work
Duration	60 minutes
Setting	classroom
Vocabulary	Geoscience, hydrology, water chemistry, water quality, pH, acids and bases, electrical conductivity
Standards Addressed	MT 2.2 – classify objects based on physical characteristics
Objectives	**Students will:** **● Be able to define the basics of pH (acid vs base) and give examples of an acid and base using common household materials** **● Be able to define electrical conductivity (EC) simply as the amount of dissolved salts and minerals in the water and cite how EC changes/what factors may affect EC.**
Materials	**● pH strips (wide range – 1-14 – preferred to litmus paper)** **● Household materials to test pH of (e.g. milk, distilled water, soap + water, lemon juice, tomato juice, baking soda + water, soda pop** **● EC meter** **● 4 beakers (at least 500 mL capacity)** **● At least 1.5 L deionized (DI) water for each group of students** **● Table salt** **● Stir rod** **● Clay balls of two colors – for reference below, I used blue and yellow** **● Colored pencils of the same color as the clay**
Background	This activity was used in preparation for a year-long seasonal study of water chemistry of a local river. Students measured pH, EC, water temperature, and air temperature at their field site and this activity was used to give them a background for what they were measuring and why the measurement was important and what affected the water quality parameters.

Monica Bruckner

Procedure

Overview (as full class):
Today, we're going to start a project where we observe how things like geology and weather can affect stream water chemistry.

First of all, can someone remind me what the difference between a rock and a mineral is? **(Rock is made up of mineral(s)).**

Now, if I tell you the definition of a mineral is something that is:
a) Solid
b) Crystalline (made out of crystals)
c) Naturally-occurring (we don't make it)

Think back to the rock cycle; are sediments made up of eroded and weathered rocks? **(yes)**

Then are they made up of eroded and weathered minerals? **(yes)**
Do you think that snow and ice are minerals? **(yes)**

So, knowing that sediments, snow, and ice are different minerals, how do you think minerals can affect water chemistry? **(dissolve minerals in water like dissolving Kool-Ade or Iced tea mix in water)**

Demonstrate by mixing iced tea in water and observing color and taste change(?)

Some ways we can look at changes in water chemistry are:
pH, or how acidic or basic the water is (show pH meter) acids make you pucker your lips (like this :x) while bases taste bitter. PLEASE DON'T TASTE ANY OF OUR EXPERIMENTS!
and

Electrical conductivity, or how much "salt" is dissolved in the water (show EC meter)
When I say salt here, I don't mean just salt like you use at dinner; salt also includes other minerals that are dissolved in water. The more salt that is dissolved in water, the higher its electrical conductivity (demonstrate with beakers of different [salt]).

Do you think snow has a high electrical conductivity or a low electrical conductivity **(low)**.

How do you get a high electrical conductivity? **(dissolve rocks and minerals in the water, or higher [sediment])**
pH and electrical conductivity are important to scientists because they can tell us where water comes from (e.g. we just said snow has a low EC, whereas groundwater, or the water you would drink if you had a well, would have a high EC since it travels through a lot of rock and sediment). pH and electrical conductivity are also important for biota- or living things- because some organisms can only live where it is acidic, some where it is neutral, and some where it is basic. Also, the salts dissolved in water (or the EC) are needed by organisms for sources of nutrients and energy.

So, now we will explore pH and EC by doing some experiments. Split the class into 2 – there will be a pH station and an EC station (this works best with two or more teachers if possible – if more teachers can be found, make 2 pH stations and 2 EC stations).

pH Station:
<u>Analytes (things to be tested):</u>
1) Distilled water
2) Tap water
3) Mountain Dew (pop)
4) Baking soda + water
5) Borax (laundry detergent) + water
6) Tomatoes
7) Lemon Juice
8) Soap + water

1) Ask students how we can tell the difference between acids and bases by taste—acids make you pucker your lips, bases are bitter. We don't eat all of the things we are testing (e.g. soap and laundry detergent), nor should we ever try to eat them. But these special pH papers will tell us how acidic or basic our liquids are.

2) Have students dispense liquids from source container to a smaller container. For items 3, 4, and 5, put a bit of each into a falcon tube, add water, and shake until it is dissolved or nearly so.

3) Have students hypothesize whether #1-8 will be acidic or basic.

4) Have students test the pH using the pH strips and check their hypotheses.

Monica Bruckner

EC Station:

<u>Analytes (things to be tested):</u>

4 Salt Solutions—1 Deionized water
1 Tap water
1 DI water + 1 pinch of salt
1 DI water + 2 pinches of salt

1) Have students pour DI water into the 3 beakers to a volume of ~500 mL. Have one get tap water to ~500 mL.

2) Have one student add a pinch of salt to one beaker and two pinches to another, and have them stir the beaker of water.

3) Place EC probe into the DI water, record the reading of EC and water temperature, rinse probe and blot it dry with a KimWipe. Repeat with tap water then 1 pinch of salt and 2 pinches of salt water.

GO BACK TO FULL CLASS (no more group work):

Follow-up: Water molecules and ions:

We just saw how adding salt affects the electrical conductivity of water. Just what does adding salt look like at the "chemical" level? Now we're going to build models of water molecules (or piece of water) and salts, which are made up of pieces called "ions." These ions affect the electrical conductivity of the water, such that when there are more ions, there is a higher conductivity.

1) Form clay balls out of blue clay—this is the water molecule, which is made up of 2 hydrogens and 1 oxygen.

2) Form clay balls out of yellow, green, and red clay- these are different salts—one is sodium, another is chloride, and another is potassium.

3) Place blue balls in a beaker and explain this is like the deionized water that has an EC of zero.

4) Add a few colored balls to the beaker and explain that this is like tap water, another bit of colored clay is like a pinch of salt, etc.

5) Fill in the beakers at the bottom of their laboratory worksheet.

Monica Bruckner

Assessment	Students should be able to define pH and EC simply and cite examples of common acids and bases and explain how increasing minerals and salts in water increases the EC of a solution.
Extension	In the next week, have student make hypotheses, or their best guess that can be supported with reasons, of how water chemistry, temperature, and turbidity will change through the school year. Think about all the different things that can affect water chemistry, temperature, and turbidity—things like when will we get snow and how does snow affect water chemistry (hint, think about what we just said about electrical conductivity)? Is there more or less water flowing in a stream now compared with December and compared with March, and why (where does the water come from?) How cold is it now compared with December and compared with May and how will that affect the water in the stream? Have them do the following in a field notebook or on a piece of paper: 1) Make a list of factors that might affect water temperature, water chemistry, and turbidity. 2) Write some hypotheses about how these factors will affect water temperature, water chemistry, and turbidity.