Measurement of a Stream

To the east of campus is a small stream called Soos Creek, a tributary of the Green River. We will use this small stream as an outdoor classroom this quarter. We will attempt to understand the factors that influence the stream and the changes in the stream that happen this fall quarter.

Small streams are termed “creeks” and large streams are called “rivers”. So, all creeks and rivers are streams. A stream is a product of its drainage basin.

Map of Three Drainage Basins

When we consider the water in a stream, all of that water fell as precipitation within the drainage basin for that stream. You may have noticed that although all streams have moving water, there are some major differences. Some streams are small, like the creek we will visit near GRCC, while other streams are huge, like the Mississippi and Columbia Rivers. Some streams flow fast and others flow slowly. In some streams the water is clear and in others the water is cloudy and murky. Sometimes the water in a stream is all in one channel, while other streams the water is in many separate channels.

What are some characteristics of the drainage basin could lead to the different types of streams?
Talk with your group and list some factors that determine the amount of water in a stream (for our discussion, assume that we are talking about natural streams that are not affected by humans).

If there is a water holding pond shaped like the drawing below, how might we determine the volume of the water in the holding pond? (We are asking for a method, not a number).

Water holding pond

Lakes are not shaped like a box, so how would we determine the volume of water in a lake?
A stream is different than a lake in that the water is in motion. Brainstorm some ideas how we might determine how water is flowing in a river. Describe your ideas below and feel free to sketch.

We will measure the flow of Soos Creek during our visit to the stream. We will also measure other physical characteristics of the stream, such as:

- The temperature of the water in the stream
- The acidity of the water in the stream
- The dissolved oxygen in the water

If you have ever waded into a lake or stream, you have probably felt differences in water temperature at different times of the year. We will measure the temperatures in the Celsius temperature scale. We will be measuring moving water—do you anticipate that the temperature of the water will vary in the stream during an individual visit? If you answered yes, how much variation do you expect? What reasons can you suggest for this suspected variation in water temperature?

You may have heard of the pH scale. Many soaps and other commercial products often advertise that the product is pH neutral. The technical definition of the pH scale is that pH is the “negative log of the hydrogen ion concentration”. The chemical symbol for water is H₂O. This means that there are two hydrogen atoms and one oxygen atom for each molecule of water.

An atom is the smallest unit of an element that can still be called that element. For instance, the smallest bit of gold one could have is an atom of gold. The smallest amount of oxygen that one can have is an atom of oxygen. Our model for an atom is that the protons and neutrons are found in the nucleus of the atom, while the electrons are found in the region around the nucleus. The electrons are in energy levels (sometimes called orbitals, although the electrons probably do not really orbit the nucleus in the same way a
satellite orbits the Earth). The atoms are more “stable” (non-reactive) when the number of atoms in the orbitals are a specific number. For example, the element helium is less reactive than the element hydrogen because helium has one more electron (and one more proton) and that extra electron “completes” the first orbital. Not all the orbitals will have the same number of electrons at “capacity”, but the numbers of electrons in the orbitals are predictable.

Hydrogen has just one electron and that leaves “space” for a second electron in its one orbital. Oxygen has two open spaces in its outer orbital. The oxygen atom’s electrical attraction of the two electrons from the two hydrogen atoms is what holds the water molecule together.

If we put some table salt (NaCl) into water, the salt seems to disappear as the salt dissolves in the water. The salt is broken into sodium and chlorine, but elemental sodium is a metal and chlorine is a gas at normal temperatures. Something else must be happening because when we add salt to water we do not see a metal form or gases rise from the water. The explanation is that the salt breaks into sodium and chlorine ions.

An ion is a changed particle which means that there is an extra electron or there is a missing electron. In the case of chlorine, it gains one electron that it removed from the sodium. By convention we have given electrons a charge of -1, while protons have a charge of +1 (neutrons are, neutral). Therefore, the chlorine atom gets a charge of -1 due to the extra electron from the sodium. When the chlorine atom gets a charge of -1, we call it a “chloride” ion. The sodium ion has a +1 charge due to the loss of the electron.

Water naturally breaks in separate particles. Since water is H₂O, it separates (or dissociates) into H⁺ and OH⁻ ions. The pH is a measure of the number of these two ions. In pure water, the number of H⁺ and OH⁻ ions will be equal. If we add an acid, like hydrochloric acid (HCl) to the water, it breaks apart in a similar manner creates many new H⁺ ions and we say that the water had become more acidic. If we add a base (bleach is a base), then there are more OH⁻ ions, and we say that the water is more basic or alkaline.

The pH scale is a way to measure the amount of H⁺ ions. The confusing part of the pH scale is that it is:
1) an inverse scale—the lower the pH, the higher the acidity and
2) a log scale. A pH of 5 is 10 times more acidic than a pH of 6. You can imagine that a pH of 3 is not twice as acidic as a pH of 6; it is 10 * 10 *10 or 1000 times more acidic. Relatively small variations in the pH of streams make a huge difference to aquatic organisms.
Here is a scale of pH values and the types of common products that have different pH values:

<table>
<thead>
<tr>
<th>Material</th>
<th>pH</th>
<th>Material</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead-acid battery</td>
<td>0.5</td>
<td>Rain</td>
<td>5.6</td>
</tr>
<tr>
<td>Gastric acid</td>
<td>1.5</td>
<td>Milk</td>
<td>6.5</td>
</tr>
<tr>
<td>Lemon juice</td>
<td>2.4</td>
<td>Pure water</td>
<td>7.0</td>
</tr>
<tr>
<td>Cola</td>
<td>2.5</td>
<td>Blood</td>
<td>~7.4</td>
</tr>
<tr>
<td>Vinegar</td>
<td>2.9</td>
<td>Seawater</td>
<td>7.7-8.3</td>
</tr>
<tr>
<td>Orange juice</td>
<td>3.5</td>
<td>Soap</td>
<td>9-10</td>
</tr>
<tr>
<td>Beer</td>
<td>4.5</td>
<td>Bleach</td>
<td>12.5</td>
</tr>
<tr>
<td>Coffee</td>
<td>5.0</td>
<td>Lye</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Where do fish get the oxygen they breathe? Talk with your group and write your prediction below:
**Dissolved Oxygen:**

Most people answer the previous question that fish break the water molecule apart. There are several problems with this idea. If fish do break apart water, we should see hydrogen gas bubbling out of the aquarium and the amount of water should decrease in the aquarium faster than normal evaporation rates. Breaking water into elemental hydrogen and oxygen requires large amounts of energy that fish do not have available.

The water we see in the stream is not only hydrogen and oxygen bonded together, but it is also other gases are “dissolved” in the water. So, there is free oxygen in the water that is not bonded with hydrogen. This oxygen is available to fish when the water flows over their gills. They “exhale” carbon dioxide into the water which is also dissolved. The amount of dissolved oxygen (aka dO₂ or DO) in the water is critical for fish existence. One of the factors that determine the amount of oxygen is the temperature of the water. The warmer the water, the less dissolved oxygen is found in water. If you heat a pan that is half filled with water, what do you observe that confirms this trend?

Is temperature the only factor that controls the dO₂ in the water? Explain.

While we are at Soos Creek, we will measure the amount of oxygen dissolved in the water in the creek.