Stream Lab Pre-visit

Classroom Activity

Brief Synopsis:

Students will become parts of a water molecule, as well as hydrogen and hydroxide ions in a game to understand the difference between a solution that is neutral, acidic or basic. How the pH scale works and what it means to be logarithmic will also be explored. Students may also be engaged in a project involving building a pH scale utilizing common household items to represent different pH levels.

Ages: Designed for 4th—8th grade

Time Considerations: 30 minutes

Materials: 3 containers or envelopes and 6 copies of the included printout (cut into pieces).

Vocabulary: Acidic, Basic, Hydrogen, Hydroxide, Ion, Logarithmic, Neutral, Oxygen, pH, Radical.

Outcomes:

1. Students will understand which atoms make up a water molecule.
2. Students will be able describe the difference between an acid and a base.
3. Students will be able to calculate the ionic value at each pH level.

Minnesota Academic Standards:
Science: 6.II.E.2
Math: 4.II.A.1, 4.II.B.1,&5-7, 4.III.A.1, 4.IV.A.1, 5.II.A.1, 5.II.B.1&4, 5.III.A.1, 5.IV.A.3, 6.II.B.3,4&6, 6.IV.A.1
Language Arts: 4.I.B.1, 4.III.A.1&2, 5.I.B.1, 5.III.A.1&2, 6.I.B.1, 6.III.A.1,3&6, 7.I.B.1, 7.III.A.1, 8.I.B.1&8, 8.III.A.1,2&7.

Revised Jan 2005

Preparations:

Activity: Getting to Know H2O

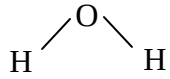
Set-up: The scientific term for water is H_2O. This means two hydrogen atoms (H_2) and one oxygen atom (O) are bonded together to form a water molecule. Pure water is made up only H_2O molecules and nothing else. On the pH scale, pure water is called neutral.

pH is a term that is used to measure how acidic or basic a solution is, ranging from 0 (very acidic) to 14 (very basic) and 7 or neutral in the center. pH stands for the "potential of hydrogen" in Latin. This refers to the fact that a water molecule can be split into two parts, a positively charged H and a negatively charged O-H. A solution is considered acidic, when there are +H ions that are not connected to an –OH. The stronger an acid, the more free +Hs there are in the solution. A solution is considered basic (or alkaline), when there are –OH ions that are not connected to a +H. The stronger the base, the more free –OHs there are in the solution.

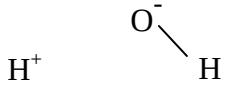
The pH scale is a logarithmic scale based on a factor of 10. This means that each step In the pH scale changes by a factor or 10. Each step is either 10 times more or 10 times less than the step next to it. The steps on the pH scale are 0 - 14.

Procedures:

1. Print off 6 copies of the included printout.
2. Cut apart the "O" and "H" cards and sort them into three separate containers or envelopes in the following way:
   Container 1: 14 H cards, 7 O cards
   Container 2: 11 H cards, 10 O cards
   Container 3: 18 H cards, 3 O cards
3. Introduce the idea of pH and water molecules using the information in the background section.
4. Draw a water molecule on the chalkboard large enough for the class to see it as you explain the scientific name for water H_2O.



5. Illustrate in your drawing what happens when a water molecule is split into two pieces. demonstrating the charges each piece has.



The positively charged H-ion is called an hydrogen ion. The negatively charged OH-ion is called an hydroxide ion.

When a solution has equal numbers of hydrogen ions and hydroxide ions, they can all pair up to neutralize their charges and become pure water, the solution is called neutral. Neutral is at the center of the pH scale (7). When a solution has more hydroxide ions than hydrogen ions, the solution will have a pH >7 and is called a base. When a solution has more hydrogen ions than hydroxide ions the

solution will have a pH of <7 and is called an acid. The extra hydroxide and hydrogen ions in acids and bases are called radicals.

Activity: Game

Background:

1. In the game, students will be drawing a card from one container and then trying to form water (H_2O) with the other students. The "O" s will first find an "H" and link arms to represent and OH-ion with a bond that will not break apart, then the "OH-ion" will have to find a lone "H" to complete the water molecule. The second "H" will put his or her hand on the shoulder of the "O" to represent a bond that can break apart.

In the first round, the students should be all groups of three (complete water molecules). If you have extra students (not divisible by 3), have one student hold both an "O" and an "H" card to represent a hydroxide ion by him or herself then link with a student holding an "H" card. Ask the students, which kind of a solution this is; acid, base, or neutral? Then have them explain why it is neutral. Have the students return their cards to the first container.

Next, have students take a card from the second container and again try to form water molecules. Remind the students that every "O" cardholder must link arms with at least one "H" cardholder. In this round there will be extra radicals. Ask the students which type of ions (hydroxide or hydrogen) are extra. When they answer hydroxide, ask the students which type of solution this is; acid, base, or neutral. Extra hydroxide ions make the solution a base. Have the students return their cards to the second container.

Finally, have students take a card from the third container and again try to form water molecules. Ask the students which type of ions (hydroxide or hydrogen) are extra. When they answer hydrogen, ask the students which type of solution this is; acid, base, or neutral. Extra hydrogen ions make the solution an acid. Have the students return their cards to the third container.

Assessment:

As a review and assessment of the activity, you will draw a graph of the pH scale to demonstrate its logarithmic shape on the board while students describe aspect of the pH scale.

Ask the students to describe the range of the pH scale (0-14). Draw this as your x-axis. Label this horizontal line as "pH Level". The y-axis (the vertical line) will be labeled "Number of Radical Ions", ranging from 0-1,000. There is an example graph included. Have your student recall where neutral is on the scale (7) and mark that as having 0 (or nearly 0) radical ions. For mathematical purposes later on, we will say there is 1 radical ion at pH 7.

Do your students remember what a logarithmic scale means from the introduction? Because the pH scale is logarithmic, each step on the scale moving away from neutral (7) will change by a multiple of 10. Have your students consider the basic side of the scale. If we measure how many radical ions are in a solution with a pH of 8, it will be 10 times the amount at pH7 = 10 radical ions. If we measure how many radical ions are in a solution with a pH of 9, it will be 10 times the amount at pH8 = 100 radical ions. Continue this pattern with your students until you reach pH10 (the scale would be too large to complete this graph on the chalkboard to plot out to pH14). Then return to pH7 and complete the acid side of the graph (down to pH4)in the same manner.

Teacher Tips

- Use the chalkboard or other visuals as much as possible when describing new vocabulary for your students.
- Print off an example pH scale with common items representing the different pH levels to show the class.
- Copy the "O" and "H" cards off onto three different colors of paper, one color for each container, to make the three sets more distinct.
- If you have time, purchase pH test strips and have your students predict the pH level of common household items and then have them test them out and label them on a pH scale.

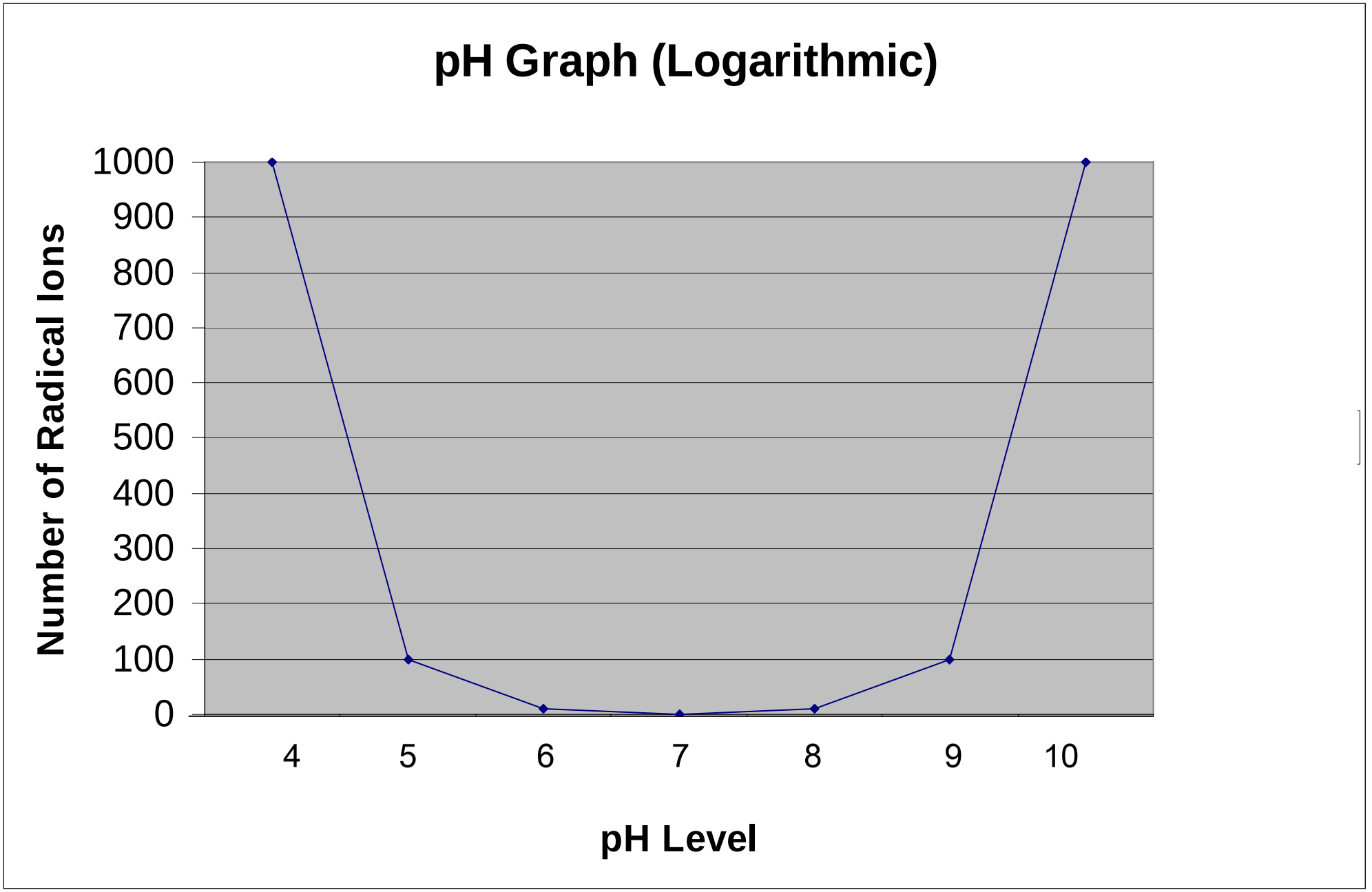
Additional Resources

http://wow.osu.edu/experiments/chemistry/pH.html
Wonders of our World page sponsored by Ohio State University gives a list the pH of common household items.

http://www.ec.gc.ca/acidrain/kids.html
A Canadian website for kids to learn about the pH scale and connecting it to acid rain.

http://www.ec.gc.ca/acidrain/kids-5-8.html
An experiment illustrating the effects of acid rain on plant growth.

http://www.chem4kids.com/files/react_acidbase.html
Kid oriented website that describes the more scientific details of acids and bases and even includes a link to an online quiz for kids to take.


pH Graph (Logarithmic)
Number of Radical Ions
1000
900
800
700
600
500
400
300
200
100
0
4
5
6
7
8
9
10
pH Level

H	O	H
H	O	H
H	O	H
H	O	H