Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

1 University Station C9000
Austin, TX 78712
(512) 471-5847
www.esi.utexas.edu

Acids and Bases

Lesson Plan for Grades: 9, 10
Length of Lesson: 2 hrs

Authored by: Maisha Rumman, for UT Environmental Science Institute
Date created: October 2014

Subject area/course: Chemistry

Materials:

1. Cabbage
2. Stove or burner
3. Pot
4. Container for cabbage juice
5. Strips of porous white paper or card sheets
6. Vinegar
7. Lemon Juice
8. Shampoo
9. Soap
10. Milk
11. Clorox Bleach
12. Computer (but can work without)

TEKS/SEs:
§112.35.
(10) Science concepts. The student understands and can apply the factors that influence the behavior of solutions. The student is expected to:
(G) define acids and bases and distinguish between Arrhenius and Bronsted-Lowry definitions and predict products in acid base reactions that form water
(I) define pH and use the hydrogen or hydroxide ion concentrations to calculate the pH of a solution

Lesson objective(s):

- Define acids, bases, and pH
- Predict and measure the pH of acids and bases
- Calculate the concentration of hydrogen ions using the pH

ENGAGEMENT

What do you think of when I say "acid" or "base"? What compounds come to mind?
Create a chart and identify what students already know or believe about acids and bases.

Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

1 University Station C9000
Austin, TX 78712
(512) 471-5847
www.esi.utexas.edu

Acids and Bases

EXPLORATION

- Students will make a cabbage indicator (or teachers can make this for students beforehand if they're concerned about safety) and use it to measure the pH of a few household acids and bases
- For instructions on how to make the cabbage indicator go to this site: http://www.funsci.com/fun3_en/acids/acids.htm#contents
- Have students get in groups and identify the pH of some common substances using the cabbage indicator (make sure to use the color scale provided in the link above): 1) Vinegar 2) Lemon Juice 3) Shampoo 4) Soap 5) Milk 6) Clorox Bleach
- What is the definition of an acid, base, and pH? Have students research online or using a textbook (resources are listed below)
- For the next part of the explanation, have students add one of the substances above to distilled water and measure pH using the cabbage indicator or a pH meter. What happens to the pH when you add the substance to water? If the pH changes, what is your explanation for why it changes based on what you know about the definition of pH, acids, and bases?

EXPLANATION

- Student explanations should precede introduction of terms or explanations by the teacher. What questions or techniques will the teacher use to help students **connect their exploration to the concept** under examination?
- List higher order thinking questions which teachers will use to **solicit *student* explanations** and help them to justify their explanations.

- Students will present in groups the pH they measured for their substances as well as what happened to the pH when they added one of the substances to water. They will present their explanation for why they think the pH changed or stayed the same.

ELABORATION

- Describe how students will develop a more sophisticated understanding of the concept.
- What vocabulary will be introduced and how will it connect to students' observations?
- How is this knowledge applied to any situation in our daily lives?
- How can this knowledge be used to explain a point in history?
- **Can this knowledge be used in any particular career field? If so, how?**

- Why are acids and bases relevant to life? Pick any topic and research.
- Some ideas to consider include: How soap works, acid reflux, the importance of antacid, how pH is maintained in blood by buffers
- Students will then pick a partner and both will teach each other about what they learned about how acids and bases are relevant.

Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

1 University Station C9000
Austin, TX 78712
(512) 471-5847
www.esi.utexas.edu

Acids and Bases

EVALUATION

- How will students demonstrate that they have achieved the lesson objective?
- This should be embedded throughout the lesson as well as at the end of the lesson

- Students will be evaluated through their answers on worksheets as well as their presentations.

SOURCES AND RESOURCES

- Dr. Laude's Hot Science – Cool Talks Lecture #91
- http://www.funsci.com/fun3_en/acids/acids.htm#contents
- http://www.chemistry.wustl.edu/~edudev/LabTutorials/Buffer/Buffer.html
- http://facultyfp.salisbury.edu/dfrieck/htdocs/212/rev/acidbase/Bronst.htm
- http://www.chemtutor.com/acid.htm#what
- http://www.scienceclarified.com/everyday/Real-Life-Chemistry-Vol-2/Acids-and-Bases-Real-life-applications.html
- http://www.chemistry.wustl.edu/~edudev/LabTutorials/Buffer/Buffer.html
- http://scifun.chem.wisc.edu/chemweek/biobuff/biobuffers.html
- http://dl.clackamas.cc.or.us/ch105-04/arrheniu.htm

Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

1 University Station C9000
Austin, TX 78712
(512) 471-5847
www.esi.utexas.edu

Acids and Bases

EXPLORATION ACTIVITY or ACTIVITIES

Purpose

Students will learn about how to make a cabbage pH detector and they will measure the different pHs of 6 common substances. They will then pick one of these substances and pour it into water and then measure the pH again. Afterwards, they will write an explanation for why the pH changes (or stays the same) when the substance is added to water. While they are conducting their exploration, they will also have a worksheet.

Materials

1. Cabbage
2. Stove or burner
3. Pot
4. Container for cabbage juice
5. Strips of porous white paper or card sheets
6. Vinegar
7. Lemon Juice
8. Shampoo
9. Soap
10. Milk
11. Clorox Bleach

Safety Information

MSDS for Clorox Bleach: http://www.thecloroxcompany.com/downloads/msds/bleach/cloroxregularbleach0809_.pdf

Procedure

1. Make a cabbage pH indicator by using the steps in the site below, relevant sections are called “Red Cabbage Juice” and “The Color Scale of Red Cabbage”
    a. http://www.funsci.com/fun3_en/acids/acids.htm#contents
2. Obtain the 6 common substances and use the cabbage pH paper strip detector and the color scale to determine what the pH of the common substances are
3. Pick one of the 6 substances and add this substance to water (don’t add the water to the substance) and measure the pH
4. Make sure students fill out the worksheet as they are completing the activity
5. Students will explain why the pH changes when adding an acid or base to water (use the equation pH = -log[H+] as well as the definitions of acids and bases)

Name: _____

Acids, Bases, and pH Worksheet

Experiment 1

Substance	Cabbage Indicator Color	Approximate pH
shampoo	Refer to cabage color wheel at: http://www.funsci.com/fun3_en/acids/acids.htm#contents	Answers vary, refer to this list: http://www.thenaturalhavenbloom.com/2012/02/ph-of-shampoo-ultimate-list.html
clorox bleach		Approx. 11 - 13
soap		Approx. 8 - 10
vinegar		Approx. 3
lemon juice		Answers vary, below 7
milk		Approx. 6.5

Definitions

Arrhenius Acid: An Arrhenius acid is a substance that when added to water increases the concentration of H^{1+} ions present

Arrhenius Base: An Arrhenius base is a substance that when added to water increases the concentration of OH^{1-} ions present

Bronsted Lowry Acid: A Bronsted-Lowry acid is defined as anything that releases H^{1+} ions

Bronsted Lowry Base: A Bronsted-Lowry base is defined as anything that accepts H^{1+} ions

pH: The pH scale measures how acidic or basic a substance is. It ranges from 0 to 14. A pH of 7 is neutral. A pH less than 7 is acidic, and a pH greater than 7 is basic.

Experiment 2

Pick one of the substances above and add it to water. Remember to add the acid to the water and not the water to the acid!

Name of your substance : _answers vary___

pH of water before addition of substance: __answer should be approx. 7___

pH of substance added to water: __answers vary____

What is the difference between the hydrogen ion concentrations in the substance by itself compared to the hydrogen ion concentration in water? What happens to the pH of the water when a substance is added to it? (Hint: what is the definition of concentration?)

Make sure to use and explain the meaning of this equation in your explanation: **$pH = -\log [H^+]$**

If an acidic substance, such as vinegar, is added to water then the pH of water will decrease because there are more hydrogen ions in the solution. When there is an increase in hydrogen ions, the pH goes down because the negative log of the hydrogen ion concentration will result in a lower pH. However, the acid just by itself will have a lower pH than when it is in water because when it is placed in water it becomes more dilute, decreasing the concentration of hydrogen ions.

If a basic substance, such as Clorox bleach, is added to water then the pH of the water will increase because there are fewer hydrogen ions in the solution. When there is a decrease in hydrogen ions, the pH will go up because the negative log of the hydrogen ion concentration will result in a higher pH. However, the base just by itself will have a higher pH than when it is in water because when it is placed in water it becomes more dilute, decreasing the concentration of hydroxide ions.

Name: _____

Acids, Bases, and pH Worksheet

Experiment 1

Substance	Cabbage Indicator Color	Approximate pH

Definitions

Arrhenius Acid:

Arrhenius Base:

Bronsted Lowry Acid:

Bronsted Lowry Base:

pH:

Experiment 2

Pick one of the substances above and add it to water. Remember to add the acid to the water and not the water to the acid!

Name of your substance : _____

pH of water before addition of substance: _____

pH of substance added to water: _____

What is the difference between the hydrogen ion concentrations in the substance by itself compared to the hydrogen ion concentration in water? What happens to the pH of the water when a substance is added to it? (Hint: what is the definition of concentration?)

Make sure to use and explain the meaning of this equation in your explanation: **pH = -log [H^+]**