Magical Careers in Environmental Chemistry

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This curriculum unit is recommended for:

Earth and Environmental Science Classes Grade 6-12
Occupational Course of Study General Science Classes 9-12

Keywords: Chemistry, Environmental Science, Global Warming, Greenhouse Gasses,

Teaching Standards: See Appendix A for teaching standards addressed in this unit.

Synopsis: Why Study Chemistry? Chemistry is essential to understanding many fields including agriculture, animal science, geology, medicine, and biology and material science. What is chemistry? "Chemistry is the science of the composition, structure, properties, and reactions of matter, especially of atomic and, molecular systems. In simplest terms, chemistry is the science of matter. Anything that can be touched, tasted, smelled, seen or felt is made of chemicals. Chemists are the people who transform the everyday materials around us into amazing things. Some chemists work on cures for cancer while others monitor the ozone protecting us from the sun. Still others discover new materials to make our homes warmer in the winter, or new textiles to be used in the latest fashions. The knowledge gained through the study of chemistry opens many career pathways. In this unit I will highlight the careers and interests of chemists in environmental fields.

Our state essential standards requires that Earth and Environmental Science students be able to, (EEn.2.6.4) Attribute changes in Earth systems to global climate change (temperature change, changes in pH of ocean, sea level changes, etc.). (EEn.2.6.3) Analyze the impacts that human activities have on global climate change (such as burning hydrocarbons, greenhouse effect, and deforestation). This unit is targeted at many of these essential standards while also enlightening my students to possible jobs in the sciences that also are interested in these very same standards.

I plan to teach this unit during the coming school year to 25 students in various high school science classes.

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Magical Careers in Environmental Chemistry

Christie C. Johnson

In recent years, science educators and curriculum developers have realized that science is taught not only to prepare students for university studies and careers in science, but also to become citizens in a society that is highly dependent upon scientific and technological advances (Hofstein 1999). High school students are naturally curious about everything that is happening around them, and through my unit I plan to help spark that curiosity in my students. I am a high school science teacher, and my Earth and Environmental Science Classes are responsible for knowing and understanding the impact human activities have on global climate change.
With this curriculum unit I plan to help my students gain a wealth of knowledge about the human impact on our environment. Through this unit I will make a connection between the chemicals that we use in our everyday lives and the environmental impacts that are having an everlasting impression on our universe. To accomplish this goal, I will use a variety of teaching strategies that will engage student's through engaging hands on activities.

My Background

When I became a special education teacher, I wanted to become the type of teacher that provided opportunities for all students to learn. Becoming a teacher was exciting. Thinking of all the good teachers I had when in school and all of the not so good experiences as well, I think of a teacher that helped me gain a vast knowledge of science and another teacher that gave me a love for math that I still have today. But most of all, my teachers gave me the love to become a lifelong learner. Wanting to give my students that same passion, tenacity, and capability to become lifelong learners, I desire to engage my students utilizing hands-on and meaningful activities. Students learning patterns are very different today, but I still want my students to develop a true sense of how learning takes place. In science, my goal is to provide students with many hands-on activities, guided notes, and scaffolding learning groups.

School Background

I have been working in the Special Education Field since 2007 and teaching in the Charlotte Mecklenburg School System for about five years. I teach a self- contained classroom at a school located in the inner city of Charlotte, NC. All of my students have some form of a disability, ranging from Autism to severe depression. Many of my students suffer from ADHD so it is very hard for them to stay engaged for long periods of time.

My school is Lincoln Heights Academy in the Charlotte-Mecklenburg School System, a large urban school district in North Carolina. Lincoln Heights Academy is a public separate setting for students with behavioral and emotional disabilities. Our school embraces the philosophy that all students can learn new behaviors, obtain new coping skills, and still master the North Carolina Common Core State Standards. Teachers are encouraged to use a variety of teaching techniques and strategies while meeting student's individual needs. We have the freedom to modify the content and the delivery of the content based on our ability to recognize our student's individual readiness for the content that we are exploring. The school has approximately 108 students consisting of several different subgroups, including 81% African-

American, 5% Hispanic, and 3% Multi-Racial, 1% Native American, 10% White; Female, Male, economically disadvantaged, and non-economically disadvantaged. All of our students have some form of a disability.

School District Learning Requirements

Our state essential standards requires that Earth and Environmental Science students be able to, (EEn.2.6.4) Attribute changes in Earth systems to global climate change (temperature change, changes in pH of ocean, sea level changes, etc.). (EEn.2.6.3) Analyze the impacts that human activities have on global climate change (such as burning hydrocarbons, greenhouse effect, and deforestation). This unit is targeted at many of these essential standards while also enlightening my students to possible jobs in the sciences that also are interested in these very same standards.

Chemistry & Environmental Science

Why Study Chemistry? Chemistry is essential to understanding many fields including agriculture, animal science, geology, medicine, and biology and material science. What is chemistry? "Chemistry is the science of the composition, structure, properties, and reactions of matter, especially of atomic and, molecular systems. In simplest terms, chemistry is the science of matter. Anything that can be touched, tasted, smelled, seen or felt is made of chemicals. Chemists are the people who transform the everyday materials around us into amazing things. Some chemists work on cures for cancer while others monitor the ozone protecting us from the sun. Still others discover new materials to make our homes warmer in the winter, or new textiles to be used in the latest fashions. The knowledge gained through the study of chemistry opens many career pathways. In this unit I will highlight the careers and interests of chemists in environmental fields.

Environmental Chemists

"Environmental chemist" is a general term. In fact, most chemists in the field would probably describe themselves more specifically by the work they do. This work may focus on collecting and analyzing samples, developing remediation programs, changing production processes to yield a more environmentally friendly product, providing expert advice on safety and emergency response, or dealing with government regulations and compliance issues. Work is often done in an indoor lab environment. However, when studying chemicals in the environment, a riverbed or stream may become the lab. Some companies have sophisticated indoor ecosystems in which they test their products. Others collect data outdoors, miles away from their own production sites. The problems that environmental chemists are asked to tackle are important and full of interesting science.

Agricultural Chemists

Agricultural chemistry focuses on chemical compositions and changes involved in the production, protection, and use of crops and livestock. It seeks to control and understand the processes by which humans obtain food and fiber for them-selves and feed for their animals. Agricultural chemists work with food producers to increase yields, improve quality, and reduce costs. They also study the causes and effects of bio-chemical reactions related to plant and animal growth, seek ways to control these reactions, and develop chemical products that provide help in controlling these reactions. Chemical products developed to assist in the production of food, feed, and fiber include herbicides, fungicides, insecticides, plant growth regulators, fertilizers, and animal feed supplements.

Global Warming: The Greenhouse Effect

In the 19th century, scientists realized that gases in the atmosphere cause a "greenhouse effect" which affects the planet's temperature. These scientists were interested chiefly in the possibility that a lower level of carbon dioxide gas might explain the ice ages of the distant past. At the turn of the century, Svante Arrhenius calculated that emissions from human industry might someday bring a global warming.[1] Other scientists dismissed his idea as faulty. In 1938, G.S. Callendar argued that the level of carbon dioxide was climbing and raising global temperature, but most scientists found his arguments implausible.[1] It was almost by chance that a few researchers in the 1950s discovered that global warming truly was possible. In the early 1960s, C.D. Keeling measured the level of carbon dioxide in the atmosphere: it was rising fast.[1] Researchers began to take an interest, struggling to understand how the level of carbon dioxide had changed in the past, and how the level was influenced by chemical and biological forces. They found that the gas plays a crucial role in climate change, so that the rising level of these gases in the atmosphere could gravely affect our future.

The Greenhouse effect is the rise in temperature that the Earth experiences because certain gases in the atmosphere (referred to as greenhouse gases), trap energy from the Sun. Without these gases, heat would escape back into space and living on Earth would be inhospitable with the average temperature being about 60 F lower.[1] Because of the way they warm our world, these gases are referred to as greenhouse gases. Some greenhouse gases occur naturally, while others result from human activity. The various natural greenhouse gases are: water vapor, carbon dioxide, nitrous oxide, ozone and methane. Carbon dioxide, methane and nitrous oxide, levels in the atmosphere are also enhanced by human activities of industry, transport, agriculture, organic and solid waste combustion. Fossil fuels, derived from coal and petroleum, provide the energy web used to power our industries, heat and light our homes and workplaces, and run our cars. As these fuels are burned they produce carbon dioxide and water, releasing over 50 billion tons of carbon dioxide into our atmosphere each year.[1]

These greenhouse gases don't just stay in one place after they're added to the atmosphere. As air moves around the world, greenhouse gases become globally mixed, which means the concentration of a greenhouse gas like carbon dioxide is roughly the same no matter where you measure it. Even though some countries produce more greenhouse gases than others, emissions from *every* country contribute to the problem. That's one reason why climate change requires global action. The graph below shows how the world's total greenhouse gas emissions are continuing to increase every year.

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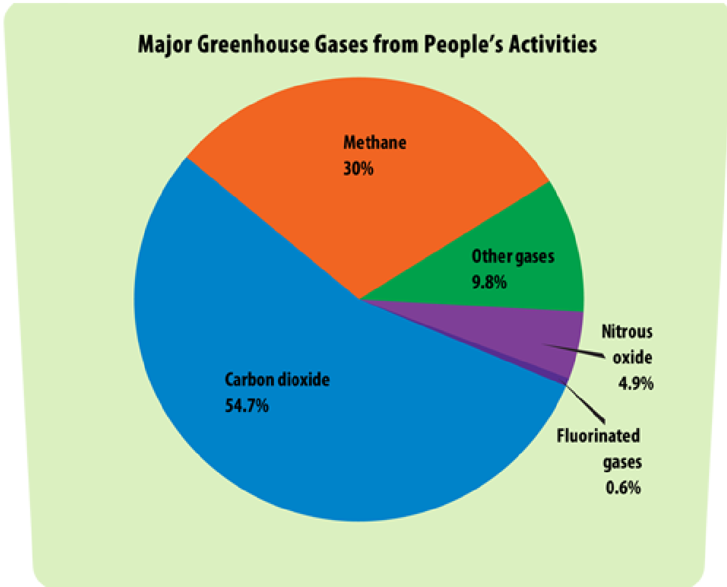
[1] Environmental Protection Agency. "Greenhouse Gases." EPA. http://www.epa.gov/climatestudents/basics/today/greenhouse-gases.html (accessed September 1, 2013).



Intergovernmental Panel on Climate Change, Fourth Assessment Report (2007).

Climate Change Effects

The Earth's climate is getting warmer, and the signs are everywhere. Rain patterns are changing, sea levels are rising, and snow and ice are melting sooner in the spring.[2] As global temperatures continue to rise, we'll see more changes in our climate and our environment. These changes will affect people, animals, and ecosystems in many ways.

Less rain can mean less water for some places, while too much rain can cause terrible flooding. More hot days can dry up crops and make people and animals sick. In some places, people will struggle to cope with a changing environment, while in other places, people may be able to successfully prepare for these changes. The negative impacts of global climate change will be less severe overall if people reduce the amount of greenhouse gases we're putting into the atmosphere and worse if we continue producing these gases at current or faster rates.

Greenhouse gases are trapping more heat in the Earth's atmosphere, which is causing average temperatures to rise all over the world. Temperatures have risen during the last 30 years, and 2000 to 2009 was the warmest decade ever recorded.[3] As the Earth warms up, heat waves are

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[2] Archer, David. *Global warming: understanding the forecast*. Malden, MA: Blackwell Pub., 2007.

[3] Gramelsberger, Gabriele, and Johann Feichter. *Climate change and policy the calculability of climate change and the challenge of uncertainty*. Heidelberg: Springer, 2011.

becoming more common in some places, including the United States.[3] Heat waves happen when a region experiences very high temperatures for several days and nights.

The choices we make now and in the next few decades will determine how much the planet's temperature will rise. While we are not exactly sure how fast or how much the Earth's average temperature will rise, we know that:

- If people keep adding greenhouse gases into the atmosphere at the current rate, the average temperature around the world could increase by about 4 to 12°F by the year 2100.[1]
- If we make big changes, like using more renewable resources instead of fossil fuels, the increase could be less—about 2 to 5°F.[1]

Higher temperatures mean that heat waves are likely to happen more often and last longer, too. Heat waves can be dangerous, causing illnesses such as heat cramps and heat stroke, or even death. Warmer temperatures can also lead to a chain reaction of other changes around the world. These increasing air temperatures also affect the oceans, weather patterns, snow and ice, and plants and animals. The warmer it gets, the more severe the impacts on people and the environment will be.

Advantages of Greenhouse Effect

The presence of carbon dioxide and other gases in the atmosphere produces the greenhouse effect, which keeps the atmosphere warm. The warm atmosphere is very essential for the survival of life on Earth in the following ways:

- Precipitation of water, formation of clouds, and rainfall etc. life in the biosphere depend on these resources.

- The warm atmosphere helps in the growth of vegetation and forest etc. These are sources of food, shelter etc.

- This effect helps in rapid bio-degradation of dead plants and animals.

These are the benefits of the greenhouse effect.

Acid –Base Reactions

Every liquid you see will probably have either acidic or basic traits. Water (H_2O) can be both an acid and a base, depending on how you look at it. It can be considered an acid in some reactions and a base in others. Water can even react with itself to form acids and bases.

A chemist named Svante Arrhenius came up with a way to define acids and bases in 1887. He saw that when you put molecules into water, sometimes they break down and release an H^+ (hydrogen) ion. At other times, you find the release of an OH^- (hydroxide) ion. When a hydrogen ion is released, the solution becomes acidic. When a hydroxide ion is released, the solution becomes basic. Those two special ions determine whether you are looking at an acid or a base.

For example, vinegar is also called acetic acid. If you look at its atoms when it's in water, you will see the molecule CH_3COOH split into CH_3COO^- and H^+. That hydrogen ion is the reason it is called an acid. Chemists use the word "dissociated" to describe the breakup of a compound.

Scientists use something called the pH scale to measure how acidic or basic a liquid is. Although there may be many types of ions in a solution, pH focuses on concentrations of hydrogen ions (H^+) and hydroxide ions (OH^-). The scale measures values from 0 all the way up to 14. Distilled water is 7 (right in the middle). Acids are found between 0 and 7. Bases are from 7 to 14. Most of the liquids you find every day have a pH near 7. They are either a little below or a little above that mark. When you start looking at the pH of chemicals, the numbers can go to the extremes. If you ever go into a chemistry lab, you could find solutions with a pH of 1 and others with a pH of 14. There are also very strong acids with pH values below 1, such as battery acid. Bases with pH values near 14 include drain cleaner and sodium hydroxide (NaOH). Those chemicals are very dangerous.

Beginnings

In ancient times, the Egyptians and Greeks defined certain substances based upon their taste. Both the Greeks and the Egyptians had discovered that one particular substance was very sour.[4] This became to be known as vinegar, which was produced from the fermentation of fruits to produce wine. Therefore, a new categorization of substances was developed that included all things that were sour.

The Greeks were also familiar with a different category of substances. They found three slippery substances left behind as residue after burning certain materials. These three substances were: potash, soda, and lime.[4] Potash, which must have been the first to be discovered, was produced from wood ashes. When some waters were produced and allowed to evaporate, the film left behind was soda. Lime was produced from burning seashells. Ultimately, the Greeks discovered a new category to define substances based upon the property of feeling slippery.

In 1386, to build on the Greek's definition of sour or slippery, a new terminology was developed to speak about things that felt slippery. From the Arabic word *al-qaliy*, which means "the ashes", the term alkaline was developed. This word was then used to speak about things that felt slippery.[4]

Fabrics in France

During the middle ages, the advancement towards defining sour and slippery substances was slow. European trading with China led to the introduction of the highly valued clothing good, silk. During the 16th century in France, fabric dyers found that when particular chemicals

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[4] Hoggan, James, and Richard D. Littlemore. Climate cover-up: the crusade to deny global warming. Vancouver: Greystone Books, 2009.

were added to the dying agent, the colors became more vibrant and even changed colors. Deeper and richer colors could be produced by adding these chemicals to the dying vats. The dyers notice that when one chemical was added to the vat, it turned the dye a red color. On the other hand, when a different chemical was added to the vat, it turned the dye a bluish-green color.

The fabric workers understood that certain substances changed the color and intensity of the dyes used in the industry. They did not need to know how it worked; they just needed to know that the dyes changed colors. For this reason, the fabric workers did not know that the dyes introduced another method for distinguishing between substances the Greeks defined as sour and slippery. Also, there was not a good understanding of the definition of alkaline, except that alkali substances were slippery. Therefore, the phenomenon was overlooked by the fabric workers and science all together.

Separating Gold and Silver

As trading with China's silk continued, Europeans were also obtaining precious metals such as gold and silver. However, these metals were often mixed together to produce an alloy. In 1626, an attempt to separate gold from silver led to an important advancement towards understanding substances that were only definable by their taste and texture.[5] It was found that the sour substances defined by the Greeks also could dissolve silver. When a sour substance was added to the gold/silver alloy and allowed to boil, the silver dissolved. After the solid gold pieces were removed, the silver was then re-obtained by allowing the sour substance to boil away. This discovery of the dissolving properties of sour tasting substances led to a new terminology. From the Latin word *acidus*, which means "sour", the term acid was developed. This term was then used to define sour tasting substances that had dissolving properties.

Discovering Salts

Johann Rudolph Glauber began as a pharmacist; however, he soon changed his line of work and became an alchemist. Living in Amsterdam, Glauber ran many experiments concerning acids and alkalis, which were not yet distinctly defined. In his laboratory, he ran many experiments and observed their reactions. A few significant discoveries Glauber made were that of *spiritus salis* (hydrochloric acid), *spirit of alum* (sulfuric acid), and *spiritus acidus nitri* (nitric acid). *Spirit of alum* and *spiritus acidus nitri* were used for separating gold and silver; however, he was the first to produce concentrated amounts of either chemical. From his experiments of these three compounds with various chemicals, Glauber noticed that some chemicals reacted violently with one another producing an effervescence effect.[5]

In 1658, he described these violent reactions as being a "battle":

The fact that acids and alkalis "battle" one another is not the only significant discovery made by Glauber. Also in 1658, Glauber noted that when an acid and an alkali react, they produce a new kind of compound called a salt.

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[5] Peatrowsky , J . "Acid/Base Cemistry." Reading, Chemistry from University of Minnesota, Minnesota, October 2, 2013.

This observation that an acid and alkali react to yield a salt was a huge advancement in acid-alkali alchemy. In fact, this led Glauber to found another important chemical salt. From one of his experiments, Glauber found that when *spirit of alum* (sulfuric acid) was reacted with ordinary table salt, that a new salt was produced. This salt was *sal mirabilis* (sodium sulfate), which was also called Glauber's salt. By producing many unattained compounds (hydrochloric acid, nitric acid, sulfuric acid, sodium sulfate, etc.), Glauber contributions to alchemy and more importantly, chemistry were very significant.[5]

With the discoveries presented by Glauber, the chemical world added another terminology and was now broken into three categories: acid, alkali, and salt. What are the properties of these three categories that make them different from one another?

Robert Boyle's Indicators

Robert Boyle was born in Ireland where he grew up until he was eight years old. He was then sent to school and traveled around Europe with a French tutor. After his stint of traveling and studying, Boyle returned to Ireland where he joined the Invisible College. The Invisible College was not actually a college at all; it was a group of prominent philosophers who inquired about questions relevant to the time period. This group later became the <u>Royal Society of London for the Improvement of Natural Knowledge</u> after it had been granted by the King of England. Boyle was named to the council and held an important role in the Royal Society.[5]

During the 17th century, the majority view of compounds suggested that all chemical compounds are composed of the same four elements: fire, earth, water, and air. For example, when a log is burned in a fire, it leads to the four elements. The log begins to combust (fire), sap flows from the wood (water), smoke rises from the log (air), and the ashes (earth) are left behind after the log is finished burning. Boyle disagreed with this hypothesis and suggested that differences in compounds were to "different textures" (configuration and cohesion of different elements). For this reason and many others, Boyle was known as the "skeptical chemist".[5] In fact, Boyle wrote his first book *The Skeptical Chemist*, which questioned the majority views of alchemy.

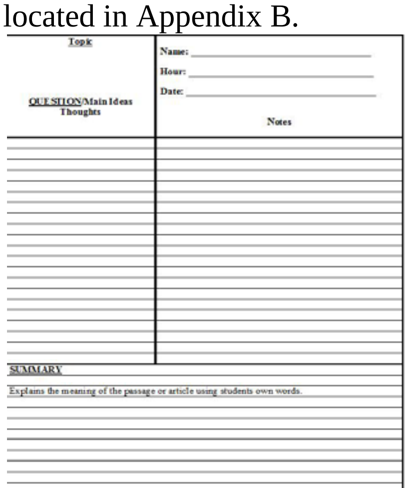
Boyle found Glauber's work interesting. The new category of salts intrigued him and helped to support his hypothesis that not everything is composed of the same four elements. Boyle began experimenting with acids and alkalis. From his experiments, he was able to fit a better definition of an acid and alkali. On top of what the Greeks and Egyptians defined as being sour and what metal purifiers noted as excellent solvents, Boyle added that acids could also precipitate certain substances.[5] Acids were very good in precipitating sulfur. On top of what the Greeks defined as being slippery, Boyle noticed that alkalis also contained "detergent properties". Alkalis were also good at dissolving sulfur and oils; and just like Glauber, he found that alkalis were good at counteracting the properties of acids. He also noticed that some chemicals do not fit into the category of an acid or alkali.[5]

Boyle continued his research of acids and alkalis and began to conduct experiments concerning how to identify an acid or alkali using indicators. He set up a number of different experiments which he published in his 1664 book *Experimental History of Colours.* Boyle knew from the French silk dyers that dyes were made from plant juices, so he began to experiment with the effects of acids on certain plant juices. He discovered what the French dyers had known a century before, only now he understood why the phenomenon they observed occurred. He noted that when an acid is placed in a jar containing a purple plant juice, the solution becomes red. Also, when an alkali is reacted with the same purple plant juice, the solution becomes bluish-green. Boyle had rediscovered an interesting and useful means of testing if a chemical was acidic or alkaline.[5] The development of acid and alkali indicators did not stop there. Boyle began to create small pieces of paper that had been soaked in lichens juice. After the paper had been removed from the juice and dried, it became a soft purple color. When the paper is touched to something acidic in character, the paper becomes red. Likewise, when the paper is touched to something alkaline in character, it becomes bluish-green. This new technique uses the same concept as the plant juice testing, but it is made much simpler by touching paper to the sample.[5]

Strategies

Cornell Note Taking

Cornell note taking is a note taking system that was designed by Walter Paulk, a professor at Cornell University. Cornell notes are divided into three sections. The first section is the questions section, which is located on the left hand side of a sheet of notebook paper. The second section is the notes section, this is the section where students and write any notes that they have taken. Last but not least is the third section, titled the summary section. The summary section is used as a tool for students to summarize the entire day's lesson. This is the time for students to focus on key ideas that were presented during the lesson. Students will use the Cornell Notes Handout, located in Appendix B.


Topic
QUESTION/Main Ideas Thoughts
Name:
Hour:
Date:
Notes
SUMMARY
Explains the meaning of the passage or article using students own words.

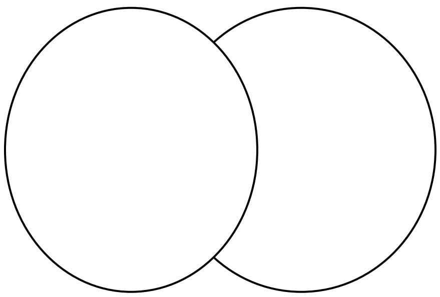
Foldables

Foldables are 3-D interactive graphic tools that help teachers and students organize and master complex information. They are a fun and engaging way for students to create a learning tool for themselves. Paper is folded, stapled or cut in a certain way and information is written inside or outside so that topics can be practiced and learned as the paper is manipulated.

Kinesthetic learners enjoy using foldables because they involve hands-on activity, as opposed to worksheets or pencil-to-paper drills. Students can review, study and take the foldables with them in their backpack. Visual learners are intrigued as well, usually with graphs and diagrams they draw when creating foldables.

Graphic Organizers

There are two types of graphic organizers commonly used to compare different objects. A Venn- Diagram is used to compare two objects similarities to the objects differences. A Venn - Diagram provides students a visual display of the similarities and differences between two items. In this unit we will use a Venn-Diagram to compare various chemistry concepts.



K-W-L Chart

As a warm up activity, students will begin by completing a KWL chart. Students will brainstorm, K- what they know for example about global warming, acid/base reactions, the greenhouse effect. W- What they want to know about global warming, acid/base reactions, the greenhouse effect. L- What they have learned about global warming, acid/base reactions, and the greenhouse effect will be completed at the conclusion of this curriculum unit. (See Appendix B) We can then move on to topics such as global warming and acids and bases using these K-W-L charts in preparation of the activities to come.

K- What I Know	**W- What I Want To Know**	**L- What I have Learned**

Students Activities

Activity 1: Anticipation Guide: Careers in Chemistry

Name____

Block_____ Date_______

Pre-Lesson		**Careers In Chemistry**	*Post Lesson*		
Agree A	Disagree B		True A	False B	Evidence
1.		Environmental chemists are concerned with acid/ base reactions.	1.		
2.			2.		
3.			3.		
4.			4.		
5.			5.		
6.			6.		
7.			7.		
8.			8.		
9.			9.		
10.			10.		

Activity 2:

Plant Juice and Litmus Paper as an Indicator

Purpose

The purpose of this experiment is to characterize some everyday samples as acidic, basic, or salt. To conduct this experiment, red cabbage juice and litmus paper will be used as indicators. Also, discuss the results by comparing to the original hypothesis of each chemical as it pertains to Boyle's description on acid and base properties.

Supplies

The supplies needed for this experiment include: red cabbage juice (provided by the teacher), a hotplate, a pot, a filter or strainer, litmus paper, baking soda water, vinegar, lemon juice, lime juice, soda pop, hand soap, dish soap, tap water, distilled (bottled) water, salt water, vegetable oil, several small cups , and plastic pipettes.

Preparation for the Teacher

To make the red cabbage juice indicator:

1. Blend some red cabbage leaves in a blender along with ½ cup of distilled water.
2. Boil the cabbage leaves for 10 minutes.
3. Filter the cabbage chunks from the now bluish-purple solution.
4. Allow for the cabbage solution to cool.
5. Place a small beaker containing the cabbage solution at each lab station.

Application

From the record of French silk dyers, Boyle used various plant juices to measure the character of certain chemicals. This led to his development of litmus paper. From his experiments, he determined that plant juices and litmus paper turn red when in contact with acids. He also determined that plant juices and litmus paper turn bluish-green when in contact with bases. This experiment gives students a first-hand look at Boyle's work and allows them to work in a historical setting.

Plant Juice and Litmus Paper as an Indicator In this experiment, you will be testing various acids and alkalis with red cabbage juice and litmus paper indicators. This experiment was first performed in 1664 by Robert Boyle, who from his work with plant juices developed litmus paper. Litmus paper is a form of plant juice indicator, and it still has applications today in the laboratory industry, and by chemists that might be interested in doing quick tests on environmentally important samples such as streams or lakes or air samples..

Boyle's work showed that acids change plant juice and litmus paper from purple to red. Alkalis, on the other hand, change plant juice and litmus paper bluish-green. Using this knowledge, determine whether some common everyday items are alkaline or acidic.

Procedure

1. From the list of samples that will be tested, make a hypothesis as to whether it is acidic, basic, or neutral.
2. Obtain a small amount of each sample listed on **Table 1** and place each in an individual dixie-cup.
3. Use your plastic pipette to gather some cabbage juice and squirt a few drops on each sample.
4. Observe the effects of the cabbage juice on the sample. Record your observations in **Table 1**.
5. Now using the litmus paper, touch the sample with the litmus paper.
6. Observe the effects of the sample on the litmus paper. Record your observations in **Table 1**.
7. Determine if the sample is an acid, a base, or neutral. Record your answer in **Table 1**.
8. Answer the questions on the back of this sheet.

Table 1

SAMPLE	Hypothesis (acid, base, neutral)	Plant Juice	Litmus Paper	Acid, Base, Neutral?
baking soda water				
vinegar				
lemon juice				

lime juice				
soda pop				
hand soap				
dish soap				
tap water				
distilled water				
salt water				
vegetable oil				

Questions

1. From what you know about Boyle's characteristic properties of acids and alkalis, think about some of the characteristics of each sample in this lab. What do your determined acids have in common? What do your determined bases have in common?
2. Which is an easier method of testing acidity: plant juice or litmus paper? Explain your reasoning.
3. What were the effects of neutral compounds on the plant juice and litmus paper?

Activity 3: Careers in Environmental Science Report

Write a report on an environmental science-related career, including the following components:

Job Description

- What is the job title?
- What are typical job responsibilities?
- What aspects of the job interest you most?
- What are the working conditions?

Training and Education

- What classes should one take in high school?
- What science and math classes are necessary in college?
- What major and what college degrees are necessary?

- What colleges offer good preparation?

Potential Earning

- What is the salary range?
- What benefits can one expect?
- Include a job announcement from an internet site.

Job prospects

- What is the employment outlook for the coming five to ten years?
- Is this an expanding , static or shrinking field ?
- Who are the potential employers?

Activity 4: Acid Rain Experiments – Observing the Influence of Acid Rain on Plant Growth

Acid rain most often damages plants by washing away nutrients and by poisoning the plants with toxic metals. It can, however, have direct effects on plants as well. In this experiment you will observe one of the direct effects of acid water on plant growth. The experiment will take about two weeks.

Materials

- 4 cups or jars
- distilled water
- white vinegar
- measuring cups
- stirring spoon
- 2 cuttings of a philodendron plant (1 leaf and small amount of stem)
- 2 cuttings of a begonia or coleus plant (1 leaf and small amount of stem)
- notebook and pencil

Instructions

1. Pour 1 teaspoon of vinegar into 2 cups of distilled water, stir well, and check the pH with either pH paper or a garden soil pH testing kit. The pH of the vinegar/water mixture should be about 4. If it is below pH 4, add a sprinkle of baking soda, or a drop of ammonia, stir well, and recheck the pH. If it is above pH 4, add a drop or two of vinegar and again recheck the pH.
2. Measure the pH of the distilled water using either pH paper or a garden soil pH testing kit. If the pH is below 7, add about 1/8 teaspoon baking soda, or a drop of ammonia, stir well, and check the pH of the water with the pH indicator. If the water is still acidic, repeat the process until pH 7 is reached. Should you accidentally add too much baking soda or ammonia, either start over again or add a drop or two of vinegar, stir, and recheck the pH.
3. Put one of the following labels on each cup or jar:
   - water philodendron
   - acid philodendron
   - water begonia (or coleus)
   - acid begonia (or coleus)
4. Pour about a cup of distilled water into the water-philodendron and water-begonia cups.
5. Pour about a cup of the vinegar/water mixture into the acid-philodendron and acid-begonia cups.
6. Put one philodendron cutting into each philodendron labeled cup, covering the stem and part of the leaf with the liquid.

7. Put one begonia cutting into each begonia-labeled cup, covering the stem and part of the leaf with the liquid.
8. Set the cups where they are not likely to be spilled and where they will receive some daylight.
9. About every 2 days, check to be sure that the plant cuttings are still in the water or vinegar/water. You may need to add more liquid if the cups become dry.
10. After 1 week, compare the new root growth of each plant in distilled water with the new root growth of its corresponding plant in acid water. Record the results.
11. After 2 weeks, again observe the plant cuttings for new root growth, and record the results.

Activity 5- EPA Kids Web Site Internet Scavenger Hunt

Go to: http://www.epa.gov/globalwarming/kids/ and find the answers.

* How many degrees has the earth warmed up over the past 100 years?

* How many degrees do scientists expect the average global temperature to increase to over the next 100 years?

* True or False: The four warmest years of the 20th century all happened in the 1990s.

* List three ways scientists gather evidence about our weather.

1.

2.

3.

* When do humans send greenhouse gases into the air? List at least five things.

Whenever you…

1.
2.
3.
4.
5.

* Why will animals and plants be more affected than humans by global climate change?

* List three things that might happen if the earth gets warmer.

1.
2.
3.

*How does recycling help make our environment a healthier place?

* Name five ways you can help make the planet a healthier place.

1.
2.
4.
5.

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Appendix A

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OA6.1	Understand how humans can have positive and negative effects on the environment.
OA6.1.1	Explain how humans can have a positive impact on natural resources.
OA6.1.2	Explain the effects of pollution on the earth, air and waterways and what can be done at the individual, family and community level to reduce pollution.

EEn.2.8	Evaluate human behaviors in terms of how likely they are to ensure the ability to live sustainably on Earth.
EEn.2.6	Analyze patterns of global climate change over time.
EEn.2.6.3	Analyze the impacts that human activities have on global climate change (such as burning hydrocarbons, greenhouse effect, and deforestation).

This curriculum unit is designed to address the standards that are documented above through hands on activities. Students will utilize a variety of teaching strategies, to meet their academic needs. With this curriculum unit students will gain a wealth of knowledge about the human impact on our environment. Through this unit you will make a connection between the chemicals that we use in our everyday lives and the environmental impacts that are having an everlasting impression on our universe.

Appendix B

Class Notes If there was no class lecture this week, write a paragraph about what you learned and/or questions about what you didn't understand. **Topic**: _____ __________ **Questions/Main Ideas:**	**Name**: ____ **Class**: ____ **Period**: ____ **Date**: ____ **Notes:**

Summary: