Lesson Title	History of Chemistry
Length of Lesson	180 min
Created By	David Wilson
Subject	Chemistry
Grade Level	9-12
State Standards	2a
DOK Level	DOK2
DOK Application	Describe and Classify
National Standards	K-12: Evidence, Models, and Explanation, 9-12: D: Earth and Space Science, G: History and Nature of Science
Graduate Research Element	The atomic emission spectra of metals in important in the identification and analysis of metals.

Student Learning Goal:

State Standards: (Chemistry)

1) Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)

National Science Standards: (K-12)

Evidence, Models, and Explanation

- Evidence consists of observations and data on which to base scientific explanations. Using evidence to understand interactions allows individuals to predict changes in natural and designed systems. Models are tentative schemes or structures that correspond to real objects, events, or classes of events, and that have explanatory power. Models help scientists and engineers understand how things work. Models take many forms, including physical objects, plans, mental constructs, mathematical equations, and computer simulations. Scientific explanations incorporate existing scientific knowledge and new evidence from observations, experiments, or models into internally consistent, logical statements. Different terms, such as "hypothesis," "model," "law," "principle," "theory," and "paradigm" are used to describe various types of scientific explanations. As students develop and as they understand more science concepts and processes, their explanations should become more sophisticated. That is, their scientific explanations should more frequently include a rich scientific knowledge base, evidence of logic, higher levels of analysis, greater tolerance of criticism and uncertainty, and a clearer demonstration of the relationship between logic, evidence, and current knowledge.

National Science Standards: (9-12)

D: Earth and Space Science: Geochemical Cycles

- The earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs. Each element on earth moves among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles.
- Movement of matter between reservoirs is driven by the earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life.

G: History and Nature of Science: Science as Human Endeavor

- Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Doing science or engineering can be as simple as an individual conducting field studies or as complex as hundreds of people working on a major scientific question or technological problem. Pursuing science as a career or as a hobby can be both fascinating and intellectually rewarding.
- Scientists have ethical traditions. Scientists value peer review, truthful reporting about the methods and outcomes of investigations, and making public the results of work. Violations of such norms do occur, but scientists responsible for such violations are censured by their peers.

G: History and Nature of Science: Historical Perspectives

- In history, diverse cultures have contributed scientific knowledge and technologic inventions. Modern science began to evolve rapidly in Europe several hundred years ago. During the past two centuries, it has contributed significantly to the industrialization of Western and non-Western cultures. However, other, non-European cultures have developed scientific ideas and solved human problems through technology.

Materials Needed (supplies, hand-outs, resources):

Be Careful and always read the Materials Safety Data Sheet (MSDS) written for chemicals you use. Federal Law requires the vendors of chemicals to provide MSDS sheets for all their chemicals

(All quantities specified here are for approximately one class.)

DAY 1

1) Crisco Soap

- Crisco (vegetable shortening) or lard

- Lye
- Hot plate
- Beaker (400-600 mL)
- Dixie cup, Pringles can, or some other soap mold

2) Flame Test

- Q-tips or wood splints
- Various salt solutions: sodium chloride, potassium chloride, calcium chloride, copper chloride, strontium chloride, lithium chloride, etc.
- Bunsen burner

DAY 2

3) Alchemist's Dream (2 procedures - - The Zinc sulfate procedure is safer, but less effective.

- Procedure 1 - http://youtu.be/_g_ml8tAnWE
  - Shiney pennies (enough for each student to have two.)
  - Hot plate
  - 30 g $ZnSO_4$ /100 mL water
  - Zn metal powder or strips
- Procedure 2 (same as above, but substitute NaOH for $ZnSO_4$)
  - 6 M NaOH (be very careful)
  - shiney pennies (enough for each student to have two)
  - hot plate
  - zinc powder

4) % Molecular Oxygen in Air

- birthday candle and matches
- test tube or graduated cylinder
- beaker or pie pan
- water

5) Electrolysis of water

- water
- pie pan
- alligator clips attached to a 9 volt battery adapter (Radio Shack)
- 9 volt battery
- graphite (removed from wooden pencils)
- 2 test tubes

Lesson Performance Task/Assessment:

Students will

- Investigate the origins of the study of chemistry.

- Recite examples of the chemical reactions that primitive humans would have been familiar with.
- Identify the significance of John Dalton and Antoine Lavoisier's work in modern chemistry.
- Explain the difference between philosophy and science as well as the importance of philosophy within the history of science.

Lesson Relevance to Performance Task and Students:
This lesson will familiarize the students with the long history of chemistry and the significant people and developments therein.

Anticipatory Set/Capture Interest:
I used a comic from The Cartoon Guide to Chemistry by Larry Gonick and Craig Criddle (ISBN: 978-0060936778) about cavemen to hook the students in the lesson.

Guided Practice:
The skill practiced in this lab is lab safety, following written directions in lab, and other skills needed to be successful and independent in lab. So, for three labs (Soap Making, Alchemist's Dream, and % Oxygen in Air), I will slowly and deliberately go through each step in the procedure before students go into the lab. Then they will be monitored to insure they understand as they go through each lab.

Independent Practice:
Although students will not work unsupervised, they will be expected to read, interpret, and implement the steps in the procedure in individual lab groups. They will be supervised, but they will have to carefully follow the directions on their own. This lab is a safe one.

Remediation and/or Enrichment:
Remediation: Individual IEP.
Enrichment: Students will choose among a list of significant Greek philosophers, alchemists, or pre-modern/modern chemists that they will do research on. Then, they will present what they learned the following day in class.

Check(s) for Understanding:
Students will be evaluated in lab. Students will be evaluated with a quiz and an exam later.

Closure:
Students will be asked to identify verbally what they learned in this lesson before the end of each period.

Possible Alternate Subject Integrations:

Most of this material can be taught in conjunction with a history class.

Teacher Notes:
Lecture/Labs/Demonstrations Sequence:

DAY 1

1) Cavemen and Chemistry
    a. Description
        i. First, I discussed the nature of chemistry being the study and manipulation of matter (and nonmatter). Then, I discussed humanity's first experiences with chemistry, i.e. fire, metallurgy, primitive medicines, dyes, brewing, etc. Next, I showed them a video about primitive metallurgy, and I demonstrated the flame test to the students. Finally, the students went into the lab to make soap in a similar way to the method used by primitive man.
    b. Video
        i. "Making History – Malachite & Copper" http://youtu.be/_OrBw4L490Y
    c. Labs
        i. Making Soap
            1. Additional References:
                a. http://www.millersoap.com/pennwaltetc.html
                b. http://wut2.com/Activities/Survival%20Trips/How%20to/making_soap.htm
            2. Procedure (attached as well):
                a. Adapted from http://littlehouseinthesuburbs.com/2008/09/homemade-old-fashioned-lard-soap.html
        ii. Flame Test
            1. Procedure:
                a. If using wood splints, soak them in water before using them.
                b. Place the Q-tips or wood splint into the metal solutions. Then, hold the Q-tip or wood splint in the burner flame.
            2. Additional Reference:
                a. http://youtu.be/oJcDOTzr5Cw

DAY 2

2) Ancient Greeks

a. I just used online pictures to discuss the philosophies of Heraclitus, Democritus, and Aristotle. I also discussed Archimedes' "Eureka! Eureka!"

3) Alchemists
   a. Here I discussed some of the significant accomplishments of the alchemists, some of which we still use today. I also discussed alchemical con men who pretended to be magic, and I discussed some of the terrible mistakes and misconceptions of some of the alchemists. In discussing the alchemists, I explained their two primary goals: 1) producing the Philosopher's Stone to make the Elixer of Life to live forever and 2) the turn base metal into gold. Then, the students went into the lab to turn silver (zinc covered) pennies into gold (brass.)
   b. Video
      i. "Pharoah's Snake" http://youtu.be/dX7xeF-ywxc
   c. Lab
      i. "The Alchemist's Dream" (Cu → Ag → Au Pennies)
         1. Procedure: http://youtu.be/_g_ml8tAnWE
4) Antoine Lavoisier
   a. After discussing Lavoisier's accomplishments and life, the students used a variation of his procedure to determine the percentage of oxygen in air.
   b. Lab
      i. "Percent Oxygen in Air"
         1. Procedure:
            a. Melt the bottom of a candle and secure the candle to the center of the pie pan.
            b. Fill the pie pan with water
            c. Light the candle and invert a graduated cylinder or test tube over the flame so that the rim is under water.
            d. As the gases above the candle cool, the water which rises into the graduated cylinder should occupy 20% of the volume of the cylinder (or test tube.)
5) John Dalton
   a. Before discussing John Dalton's accomplishments, the students were lead into the section of the lesson by performing the electrolysis of water to verify the molecular formula of water: H_2O.
   b. Lab
      i. "Electrolysis of water"
         1. Procedure:

a. Connect the battery to the battery adapter. Then, clip one piece of graphite into each of the alligator clips.
b. Fill each test tube with water then invert them in the pie pan so that they are upside down and each test tube is upside down and the rim is just under the surface of the water of the pie pan.
c. Place each of the graphite pieces under a test tube.
d. Gas should evolve at each electrode and collect into each test tube. One test tube should collect twice as much gas as the other. The hydrogen is twice as much as the oxygen.