Cool Chemistry

Grade Level: Seventh
Presented by: Sarah Joy Stanley, O.L. Slaton Junior High, Lubbock, TX
Length of Unit: Nine Lessons

I. ABSTRACT

This unit allows students to explore the history and basic principles of chemistry. Students will participate in hands-on activities to ensure mastery of such topics as ionic and covalent bonding, oxidation and reduction reactions, and acid/base identification. The students will create and complete inquiry based (open-ended) lab activities and will incorporate their data into solutions for current biological problems.

II. OVERVIEW

A. Concept Objectives:
1. Students will understand cause and effect from a scientific perspective.
2. Students will appreciate the contributions of early scientists to modern day chemistry.
3. Students will recognize current environmental and biological problems and begin to pose solutions based on their knowledge of chemical concepts.

B. Core Knowledge Content:
1. Early theories of matter
2. Start of modern chemistry
3. Kinds of bonds
4. Kinds of reactions
5. Atomic structure
6. Science Biographies - Dmitri Mendeleev

C. Skills to be taught
1. Recognize the difference between elements, compounds and mixtures
2. Identify early atomic theories of the Greek scientist, Democritus
3. Observe the importance and patterns of the periodic table
4. Participate in alchemical experiments and provide modern explanations for results such as copper turning into gold
5. Explain how atoms combine to make molecules
6. Compare the roles of electrons in ionic and covalent bonding
7. Demonstrate the ability to balance equations
8. Compare and design experiments for oxidation, and reduction reactions
9. Understand the concept of pH
10. Recognize the characteristics of acids and bases
11. Identify particular acids and bases through experimentation

III. BACKGROUND KNOWLEDGE

A. For teachers

B. For students
1. Forms of Matter (Grade 4)
2. Parts of an Atom (Grade 4)

IV. RESOURCES

See Bibliography

V. LESSONS

Lesson One: Early Theories of Matter

A. Objectives
1. Lesson Content: Early Theories of Matter
2. Concept Objective: Students will appreciate the contributions of early scientists to modern day chemistry.
3. Skill Objective:
   a. Review the four "modern" states of matter.
   b. Discuss the ancient Greek theories of matter – the four elements of earth, air, fire, water.
   c. Complete measurement of matter lab.

B. Materials
1. Lecture Notes – Appendix A1
2. Matter Lab Activity – Appendix A2
3. balance
4. graduated cylinder
5. water
6. balloons
7. string
8. rulers
9. various objects to measure

C. Key Vocabulary
1. Matter: made of molecules; Latin for "little mass"; anything that has mass and takes up space (surface area and volume)
2. Solid: form of matter with definite shape and volume
3. Liquid: form of matter with indefinite shape and definite volume
4. Gas: form of matter with indefinite shape and volume
5. Plasma: form of matter with indefinite shape and volume and electrically charged molecules

D. Procedures and Activities
1. Teacher and students discuss the four "modern" states of matter.
2. Teacher explains the beliefs of ancient scientists concerning the states of matter – earth, air, fire, and water.
3. Students take notes over the information.
4. Students create a graphic representation of the molecules of each state of matter.
5. Students participate in Matter Lab.

E. Evaluation and Assessment
1. Lab results and notebook will be assessed.

Lesson Two: Elements, Compounds, and Mixtures

A. Objectives
1. Lesson Content: Elements, Compounds, and Mixtures
2. Concept Objectives:
   a. Students will appreciate the contributions of early scientists to modern day chemistry.
   b. Students will recognize current environmental and biological problems and begin to pose solutions based on their knowledge of chemical concepts.
3. Skill Objective:
   a. Understand the difference between elements, compounds and mixtures.
   b. Complete lab activity

B. Materials
   1. Lecture notes – Appendix B1
   2. Lab supplies (depend on activity selected) – Appendix B1
C. Key Vocabulary
   1. Element: made of only one type of atom
   2. Atom: basic building block of all substances in the universe; smallest complete unit of matter
   3. Compound: substance made of heterogeneous molecules that are bonded together chemically. (hetero = different) The elements always come in definite proportions.
   4. Mixture: substance made of heterogeneous molecules that are not bonded together chemically; mixtures can be homogeneous or heterogeneous
   5. Molecule: more than one atom joined together: can be same or different atoms: O3 or H2O
D. Procedures and Activities
   1. Teacher and students review the four states of matter.
   2. Teacher and students discuss the definitions of elements, molecules, and atoms.
   3. Teacher and students discuss the early theories of Democritus and the atom.
   4. Teacher shows students graphic representations of each term.
   5. Teacher shows students examples of and defines compounds, heterogeneous mixtures, and homogeneous mixtures.
   6. Students take notes over the information.
   7. Students work on lab.
E. Evaluation and Assessment
   1. Lab results and notebook will be assessed.

Lesson Three: Review Atoms – History, Structure and Function

A. Objectives
   1. Lesson Content: Atomic Structure
   2. Concept Objectives:
      a. Students will appreciate the contributions of early scientists to modern day chemistry.
      b. Students will understand cause and effect from a scientific perspective.
   3. Skill Objective:
      a. Review the basic structures of an atom.
      b. Recognize the function of each of the atomic structures.
      c. Introduce the students to the periodic chart.
      d. Discuss the basis of placement on the periodic chart – atomic number.
      e. Identify the importance of John Dalton, Niels Bohr, and Dmitri Mendeleev to the periodic chart.
B. Materials
   1. Lecture notes – Appendix C1
   2. Periodic Charts
C. Key Vocabulary
   1. Nucleus – makes up most of an atom's mass; location of protons and neutrons
   2. Proton – positively charged particles located in the atomic nucleus
   3. Neutron – particles with no charge located in the atomic nucleus
   4. Electron – negatively charged particles located outside of the atomic nucleus
   5. Atomic number – the total number of protons in the nucleus; should be the same as the number of electrons because atoms want to be neutral
   6. Atomic mass – the total number of protons and neutrons in the nucleus

7. Ion – when the number of electrons varies within the atoms of an element
8. Isotope – when the number of neutrons varies within the atoms of an element

D. Procedures and Activities
1. Teacher defines the parts of an atom: proton, neutron, electron, nucleus
2. Teacher explains atomic number and atomic mass.
3. Teacher and students observe the periodic chart and discuss organization.
4. History of the periodic chart: Dmitri Mendeleev

E. Evaluation and Assessment
1. I have… Who has? Periodic chart game

Lesson Four: The Periodic Chart

A. Objectives
1. Lesson Content: The Periodic Chart
2. Concept Objective: Students will understand cause and effect from a scientific perspective.
3. Skill Objective:
   a. Continue studying the periodic chart.
   b. Discuss atomic symbols and naming the elements.
   c. Discuss families and periods of the chart.
   d. Research an element.

B. Materials
1. Lecture Notes – Appendix D1
2. Periodic charts
3. Art supplies for Chemical Characters – Appendix D2

C. Key Vocabulary
1. Period – a horizontal row on the periodic chart
2. Family – a vertical column on the periodic chart
3. Metals – ductile, malleable, good conductors, lustrous
4. Nonmetals – opposite characteristics of metals
5. Metalloids – characteristics of both metals and nonmetals

D. Procedures and Activities
1. Teacher and students observe the periodic chart and discuss the atomic symbols and names of elements. – Appendix D2
2. Students receive a list of element names and symbols to memorize.
3. Teacher and students discuss the families and periods of the chart.
4. Students will research and element, create a "Chemical Character," and report to the class.

E. Evaluation and Assessment
1. Element and symbol quiz
2. Chemical Characters

Lesson Five: Alchemy in the Middle Ages

A. Objectives
1. Lesson Content: Alchemy
2. Concept Objectives:
   a. Students will appreciate the contributions of early scientists to modern day chemistry.
   b. Students will understand cause and effect from a scientific perspective.
3. Skill Objective:
   a. Explain the role of alchemists in the Middle Ages

b. Participate in alchemical experiment and provide modern explanations for results such as copper turning into gold

B. Materials
1. Lecture notes – Appendix E1
2. Lab Supplies: pennies, zinc powder, NaOH, bunsen burners, matches, tongs, goggles, ring stand

C. Key Vocabulary
1. Alchemy- an ancient, mystical practice that preceded the science of chemistry. Alchemists tried to convert common, inexpensive metals into gold.

D. Procedures and Activities
1. Teacher provides background information about alchemy.
2. Students discuss the ideas behind alchemy.
3. Students complete alchemy lab.

E. Evaluation and Assessment
1. Lab results and notebook will be assessed

Lesson Six: Atomic Bonds

A. Objectives
1. Lesson Content: Atomic Bonds
2. Concept Objective: Students will understand cause and effect from a scientific perspective.
3. Skill Objective:
   a. Recognize the difference between atoms and molecules
   b. Understand the difference between ionic and covalent bonds

B. Materials
1. Lecture Notes – Appendix F1
2. Periodic Charts
3. Construction paper and colored pencils – Appendix F2

C. Key Vocabulary
1. Ionic bonds – bonds between metal and nonmetal
2. Covalent bonds – bonds between two nonmetals
3. Valence electrons – outermost electrons used in bonding

D. Procedures and Activities
1. Teacher reinforces knowledge of metals, nonmetals and metalloids
2. Teacher provides notes concerning ionic and covalent bonds
3. Students participate in bonding role-play
4. Students create cartoon example of ionic and covalent bonds.

E. Evaluation and Assessment
1. Bonding Cartoon

Lesson Seven: Balancing Equations

A. Objectives
1. Lesson Content: Balancing Equations
2. Concept Objective: Students will understand cause and effect from a scientific perspective.
3. Skill Objective: Students will practice balancing equations

B. Materials
1. Lecture Notes – Appendix G1
2. List of equations

C. Key Vocabulary
1. Chemical equation – describes chemical reactions by using chemical formulas

2. Reactants – found to the left of the yield sign – elements and compounds before a chemical change has taken place
3. Products – found to the right of the yield sign – elements and compounds after a chemical change has taken place
4. Coefficient – number placed before chemical symbols
5. Subscript – number placed below and after a chemical symbol; tell the number of atoms of that element that are present

D. Procedures and Activities
1. Teacher provides notes and examples to teach the necessary steps for balancing equations
2. Teacher provides list of chemical equations
3. Students draw symbols to represent the elements in each equation

E. Evaluation and Assessment
1. Student completed equation worksheet

Lesson Eight: Oxidation and Reduction Reactions

A. Objectives
1. Lesson Content: Oxidation and Reduction
2. Concept Objective: Students will understand cause and effect from a scientific perspective.
3. Skill Objectives:
    a. Review the basic components of equations and balancing equations
    b. Introduce the students to oxidation and reduction reactions
    c. Discuss everyday encounters with these reactions
    d. Explore oxidation and reduction reactions through lab activities

B. Materials
1. Teacher notes – Appendix H1
2. Lab supplies based on selected labs

C. Key Vocabulary
1. Oxidation – occurs when an atom loses an electron
2. Reduction - occurs when an atom gains electrons

D. Procedures and Activities
1. Teacher reviews the basic components of equations
2. Teacher introduces oxidation and reduction
3. Students complete lab activities

E. Evaluation and Assessment
1. Lab results and notebook will be evaluated

Lesson Nine: Acids and Bases

A. Objectives
1. Lesson Content: Acids and Bases
2. Concept Objectives:
    a. Students will recognize current environmental and biological problems and begin to pose solutions based on their knowledge of chemical concepts.
    b. Students will understand cause and effect from a scientific perspective.
3. Skill Objective:
    a. Introduce the concept of pH, acids and bases
    b. Recognize and identify acids and bases
    c. Conduct experiments with acids and bases

B. Materials
  1. Teacher notes – Appendix I1
  2. Litmus paper
  3. Lab supplies based on activities selected
C. Key Vocabulary
  1. pH – stands for percent Hydrogen. pH is measured by an indicator that changes color depending on whether an acid or base is present.
  2. Litmus paper - a pH indicator that turns red in the presence of acids and turns blue in the presence of bases
  3. Acids – produce H+ ions when dissolved in water; they are sour and corrosive
  4. Bases – produce OH (hydroxide) ions when dissolved in water; they are bitter and can be corrosive
D. Procedures and Activities
  1. Teacher presents background information and key vocabulary
  2. Students engage in multiple acid/base lab experiments
E. Evaluation and Assessment
  1. Lab results and notebook will be evaluated

VI. CULMINATING ACTIVITY

See Appendix JI

VII. HANDOUTS/WORKSHEETS

See attached Appendices

VIII. BIBLIOGRAPHY

Churchill, E. Richard. Amazing Science Experiments with Everyday Materials. New York: Sterling Pub. Co., 1991. ISBN 0-8069-7372-2

Gallant, Roy A. Explorers of the Atom. New York: Double Day and Co. Inc., 1974, ISBN 0-385-03583-7

Gray, Harry B., Simon, John D., and Trogler, William C. Braving the Elements Sausalito, California: University Science Books, 1995, ISBN 0-935702-34-2

Gay, Kathlyn. Science in Ancient Greece. New York: Franklin Watts, 1988, ISBN 0-531-10487-7

Herbert, Don. Mr. Wizard's Supermarket Science. New York: Random House, 1980, ISBN 0-394-83800-9

Hill, John W. Chemistry for Changing Times. New York: Macmillan Pub. Co., 1992, ISBN 0-02-355070-8.

Mandell, Muriel. Simple Science Experiments with Everyday Materials. New York: Sterling Pub. Co., 1989, ISBN 0-8069-6794-3

Melbane, Robert C. and Rybolt, Thomas R. Everyday Material Science Experiments: Metals. New York: Twenty-First Century Books, 1995, ISBN 0-8050-2842-0

Parratore, Phil M. Chemistry. Cypress, California: Creative Teaching Press, Inc., 1995, CTP 2806.

Parratore, Phil M. Matter. Cypress, California: Creative Teaching Press, Inc., 1995, CTP 2805.

Stwertka, Albert. The Scientific American Sourcebooks: The World of Atoms and Quarks. New York: Henry Holt and Co., 1995, ISBN 0-8050-3533-8

Snyder, Carl H. The Extraordinary Chemistry of Ordinary Things. New York: John Wiley and Sons, Inc., 1995, ISBN 0-471-31042-5.

Ward, Pat and Barbara. The Atom: Building Block of Nature. Mark Twain Media, Inc., 1995, ISBN 1-58037-054-3.

Wiese, Jim. *Magic Science*: 50 Jaw Dropping, Mind-Boggling, Head-Scratching, Activities for Kids. New York: John Wiley and Sons, Inc., 1998,
ISBN 0-471-18239-7
Wohlrabe, Raymond A. Metals. Philadelphia: J. B. Lippincott Co., 1964.

Appendix A1: Cool Chemistry

Lesson One: Matter Lecture Notes

Matter is … made of molecules
anything that has mass and takes up space

There are four types of matter: solid, liquid, gas, plasma

Solids – have definite shape and volume
What equipment would you use to measure the shape and volume of a solid?
Why are solids "solid"? Inside a solid, the molecules are packed together very tightly and do not move around very much. This gives the solid its definite shape and volume.

Liquids – have indefinite shape (take shape of container) and definite volume
What equipment would you use to measure the shape and volume of a liquid?
Why are liquids "liquid"? Molecules of liquids are spread out and have more room to move around. When they are poured into a new container, this flexibility allows them to change shape.

Gas – has indefinite shape and indefinite volume
What equipment would you use to measure the shape and volume of a gas?
Why is gas "gas"? Molecules of gases are very spread out and have a lot of room to move around. Gas molecules move quickly.

Plasma – has indefinite shape, indefinite volume, and electrically charged particles
What equipment would you use to measure the shape and volume of plasma?
What is an example of plasma, and why is it considered "plasma"? The sun and lightning are made of plasma. Plasma molecules are very spread out and have room to move around, but they keep a shape (unlike gas) because they have a greater electrical charge and attraction for each other.

In ancient times, people thought that there were four basic states of matter, or four basic elements. These four elements were earth, air, fire and water. The ancient Greek philosopher, Aristotle, believed that all substances were made of different combinations of the four (pure) elements. Actually, the Greeks were not far off the mark … anything earth was a solid; anything water was a liquid; anything air was a gas.

Aristotle was also correct in thinking that most substances were not pure. Today most of our basic states of matter are not pure. Concrete is a solid, but it is made of gravel or stone mixed with cement. The ocean is made of water, but even water is not pure … when it evaporates certain salts remain.

Our states of matter are made of molecules. As you learned earlier, elements are made of only one type of atom. What are atoms?

Appendix A2: Cool Chemistry

Lesson One: Matter Lab
Provide different samples of solids and liquids for the students to measure. (This is great experience for the students to use balances, metric conversions, and graduated cylinders.)

All matter has mass. Mass is measured in grams and kilograms; mass does not change based on location. (The gravitational forces exerted on an object determine its weight.)

Volume is the amount of space that something occupies. Liquid volume is measured in mL and liters. Volume of a solid is measured in cm3. The volume of an object can change … for example your lungs.

Density measures how much matter is packed into a given volume of space. Density is also known as specific gravity. Density = mass/volume

1. Students create a chart with columns for mass, volume and density.
2. Students mass the objects with a balance.
3. Students find the volume of objects by pouring 50 mL of water into a graduated cylinder (water displacement). The students place the object into the graduated cylinder and record the new volume. To find the volume of the object, subtract the new volume from the original volume.

What connections can you make between the mass, volume, and density of these objects?

When they have finished measuring the solids and liquids, ask the students to brainstorm ways to measure gases. This activity will allow them to measure air.

1. Provide lab partners with two balloons, one ruler, and three strings of equal length.
2. The students tie the two strings one inch from each end of the ruler. The students tie the third string to the center of the ruler. (This will be the fulcrum.)
3. The students measure the size and weight of the empty balloon and tie it to one string at the end of the ruler.
4. The students inflate the other balloon, tie it off, and measure the size and weight.
5. The students tie the inflated balloon to the string at the opposite end of the ruler from the empty balloon.
6. The ruler should tilt toward the side with the inflated balloon. This proves that the air inside the balloon has mass (weight).

Ask the students to compare the volume of the balloon to the volume of lungs.

This is also a great time to introduce colloids (cornstarch and water) to the students. Have them put the substance into a category based on their observations and knowledge of matter.

Colloids are mixtures created when the tiny particles of one substance scatter evenly throughout another. Colloids change form under pressure. The pressure forces the cornstarch particles together, and the mixture becomes solid. When the pressure is released, the mixture returns to its original liquid form.

How does pressure affect solids, liquids, gases and plasma?

<u>**Appendix B1: Cool Chemistry**</u>

Lesson Two: Elements, Compounds, and Mixtures
Matter is divided into three groups – solids, liquids, gases and plasma. We also discovered that matter is made of molecules … molecules of what?
<u>Molecules</u> are more than one atom joined together. The atoms can be the same or different.

Ex: Ozone is three atoms of Oxygen (O3)
Water is two atoms of Hydrogen and one atom of Oxygen (H2O)

<u>Atoms</u> are the basic building blocks of the universe. Atoms are the smallest unit of a pure substance in the universe. If a substance has only one type of atom, it is called an <u>element</u>.
In the known universe, there are only 109 known elements! 90 of them occur in nature, and the other 19 are man made.

In ancient Greece, a young man "discovered" atoms by looking at the ocean and the beaches. This young scientist was Democritus. Democritus looked at the water and sand and saw that they were made of smaller particles. He named these particles *atomos*. (*Atomos* means indivisible; cannot be divided.) He believed that atoms came in different sizes and shapes so that they could join to make objects with different properties.
Democritus was right! Pretty good for someone who lived in 460 B.C. to 370 B.C.

Atoms make up elements … atoms of elements join together to form molecules.

Molecules of elements that join and <u>chemically bond</u> are called compounds. (H2O, NaCl, CO2)

Compounds are made of <u>heterogeneous</u> (different) molecules. Hydrogen + Oxygen; Sodium + Chlorine, Carbon + Oxygen

Molecules of elements that join but are not chemically bonded together are called mixtures. (soil, air, blood)

Lesson Two: Lab Activities
In cooperative groups of four, have the students brainstorm a list of substances. The students should categorize the substances into elements, compounds, or mixtures. As a class, have each group call out their substances. If any of the other groups selected that specific substance, all groups must cross it off their list. The group with the most substances wins. (Similar to the game Scattergories)

Require the students to research and graphically display the elements and compounds that combine to make our air. (This is a great activity for the students to work with charts and graphs, percentages, acquiring/analyzing/communicating/comprehending scientific data.)

Require the students to create mixtures that can be separated by physical means … muddy water, salt crystals and iron filings, car oil and water. Provide different pieces of equipment (filters, magnets) for the students to incorporate into their experiments.
The students should predict the best method and materials for separating the mixtures. They should create and carry out the experiment they designed.
At the end of the experiment, ask the students to analyze their data and procedures. Did they pick the best method for separating the mixture? How are separating/filtering methods used in society? How could their method be used to help the environment?

Appendix C1: Cool Chemistry

Lesson Three: Atoms – History, Structure and Function

The ancient Greeks were the first to "discover" the atom, and they thought that the atom was the smallest particle created. Little did they know that the atom is actually made of smaller, subatomic particles. John Dalton, an English chemist and physicist, was the first scientist to define the atom as we know it today. He explained that chemical reactions do not change the atoms – only the way they are arranged. He said all atoms of a given element were like each other but different from every other element. (We call these isotopes and ions.) He also recognized that atoms are what make up molecules.

The center of the atom is called the nucleus. (What other things have a nucleus? Why is it important?)

Inside the nucleus we find protons and neutrons.
- Protons are positively charged particles.
- Neutrons are particles with no charge.
- (What is the charge of the nucleus?)

Outside the nucleus we find electrons.
- Electrons are negatively charged particles.
- Electrons surround the nucleus and form an electron cloud. This cloud makes up most of the atom's space but little of its mass.

Electrons are very important because they are used in bonding with other atoms.
Niels Bohr was a Danish physicist who figured that electrons traveled around the nucleus in a fixed orbit. He compared them to the planets traveling around the sun. Niels also found that electrons usually remain in their lowest possible energy levels, but they can jump energy levels and get "excited".
- Electrons have four major energy levels:
  - 1^{st} orbital/energy level holds 2 electrons
  - 2^{nd} orbital/energy level holds 8 electrons
  - 3^{rd} orbital/energy level holds 18 electrons
  - 4^{th} orbital/energy level holds 32 electrons
  - the other levels can hold 50, 72, and 98 electrons
- To be stable … electron orbitals want to be full or have eight electrons

Atoms of elements are unique because they all have the same number of protons, neutrons, and electrons.
All oxygen atoms have 8 proton, 8 neutron, and 8 electron
All atoms of oxygen have these numbers except …
- When the number of electrons varies … then the atom is called an ion.
- When the number of neutrons varies … then the atoms is called an isotope.
  - Carbon 12 has 6 protons and 6 neutrons
  - Carbon 14 has 6 protons and 8 neutrons

Look at the periodic chart. (Do you see any organization? Why do you think it was arranged this way?)

The periodic chart is organized according to atomic number. The atomic number tells us the number of protons in the nucleus. (Why protons? They never change in number. If we want atoms to be neutral, what else does the atomic number tell us? How many electrons there should be?)

Under the symbol you will see another larger number. That number is the atomic mass. This tells us the weight of the protons and neutrons. It also helps us find the number of neutrons. How? Subtract the known number of protons (atomic number) from the atomic weight … this tells you the number of neutrons.

This seems like a very reasonable way to organize the periodic chart, but it wasn't always this way. In 1864, an English scientist, John Newlands, organized the known elements according to their mass. The elements with the least mass were first on the periodic chart.

In 1869, a Russian scientist, Dmitri Mendeleev, organized the periodic chart into a format very similar to the one we use today. Dmitri organized the elements by their properties and their atomic mass. Each column in the chart was called a family or group. (Families contain elements with similar properties.) Each row was called a period. (The atomic mass of ele ments increases as you move from right to left along a period.) Mendeleev was very wise in his organization of the chart; he left room for other elements because he was sure that more would be discovered.

In modern times, our periodic chart is very similar to Mendeleev's chart. One major difference is the inclusion of the atomic number. The rows are still called periods, and they increase as you move from right to left. Now the periods list the elements by atomic number, increasing by one as you move from right to left along the period.

Lesson Three: Lab Activities

This lab takes a little teacher preparation time, but the students really enjoy it.

Create a stack of 3x5 cards. On each card, the atomic number, atomic symbol and atomic mass should be listed. On the back of each card a "Who has …?" statement is provided. The teacher starts the game with a question …

Who has 20 protons?

The student with the Calcium card answers … "I have. My element is Calcium." On the back of Calcium's card is the question, "Who has no neutrons?" After Calcium reads the card aloud, the student with the Hydrogen card answers … "I have. My element is Hydrogen." The game repeats until all the cards have been called/answered.

After a couple practice runs, the students love to time themselves and compete with other classes.

Appendix D1: Cool Chemistry

Lesson Four: The Periodic Chart

As we look at the periodic chart we see the atomic number and atomic mass, but we also see letters. These letters are symbols for each of the elements.

The symbols … are one, two or three letters

first letter is capitalized and second/third are lower case

The scientists around the world needed a common periodic chart, so the symbols were agreed upon. For most of the elements the symbol is the first letter of the name, but not all of the names are in English. Hydrogen = H and Helium = He, but Gold = Au. Where did that come from?

Some of the elements are Latin or Greek.

Gold comes from the Latin word *aurum* thus the symbol Au for gold.

Some of the elements are named for their characteristics.

Bromine comes from the Greek word that means "bad smell" … and it does!

Some of the elements are named for the place where they were discovered or developed.

Californium or Berklium

Some of the elements are named to honor individuals.

Einsteinium

What are some things that you could use to name an element?

Now look at the vertical columns of the periodic chart; these are called families or groups.

There are 8 major columns – not including the transition elements.

The columns also tell you how many electrons are in the outermost level of the electron cloud.

(These are called valence electrons and are used in bonding.)

The first column, excluding Hydrogen, is called the alkali metals.

Alkali metals are highly reactive, burn in air, and react violently with water.

(If they are so reactive, how would you store them?)

The second column is called the alkaline earth metals.

Alkaline earth metals react with water and are important for industry.

The seventh column is called the halogen family.

Halogens are highly reactive and are not commonly found free in nature.

The eighth column is called the noble gas family.

The noble gases are the most stable family. They are colorless, tasteless, and odorless.

The elements are also grouped according to other physical properties.

Elements on the left side of the periodic chart are generally metals.

Metals are … ductile – able to be pulled into a thin wire easily

malleable – bend easily

lustrous – shiny

good conductors of electricity

Elements on the right side of the periodic chart are generally nonmetals.

Nonmetals are not ductile

not malleable – they are brittle and break easy

not shiny

not good conductors of electricity

Elements in the middle of the periodic chart are called metalloids or transition metals. They have characteristics of both metals and nonmetals.

Now look at the horizontal lines of the periodic chart. These rows are called periods. Periods increase in atomic number and mass as you move from right to left across the periodic chart. The periods also change from metal – metalloid – nonmetal as you move across the periodic chart.

Appendix D2: Cool Chemistry

Lesson Four: Periodic Chart Activities

Naming the elements:

Have the students brainstorm different names that they respond to and have them create an element named after them.

Example: Ms. Stanley = Sarah, Bear, Sister, Teacher, Friend, Aunt, UIL Coach etc.

Pick symbol for new element to represent you --- but be careful not to use one that is already on the chart.

Chemical Characters: (Adapted from Mary Lou Guerra)

Cut out elements from a copy of the periodic table. Place the elements in a hat and have the students draw two elements from the hat.

On poster board:

1. Create chemical character (decorate, color etc.)
   Iron Man, Mercurita
2. Write a creative short story using chemical characteristics and common uses of your element.
3. Include atomic number, chemical symbol, chemical name, atomic weight, and valence electron numbers

Allow the students to use the library for research on characteristics, common uses etc.

You could make this into a mock-pageant by calling it the Periodic Parade. Invite parents and other guests; have the students make costumes to match their chemical characters.

Appendix E1: Cool Chemistry

Lesson Five: Alchemy in the Middle Ages

Alchemy was practiced heavily during the Middle Ages (AD 1400 to AD 1650). The main purpose behind the study of alchemy was the transmutation of common, inexpensive metals into gold. Alchemists believed that all substances came from one kind of matter … earth, air, fire, or water. Each substance had different proportions of these four elements. Gold and silver had the proper proportions, but other metals, like lead and copper, were out of proportion. Alchemists hoped that with just the right help, these other metals could be turned to gold.

Looking at what scientists can do today, do you think it is possible to change an element into another? Why or why not?
Lead and Gold are only three electrons and protons away from each other.
Sand can be turned into glass, transistors, and computer chips.
Crude oil can be turned into plastics, pesticides, drugs, and detergents.
Diamonds are made from carbon.

Lesson Five: Alchemy Activities
Students research some of the technological advances achieved by modern chemists.

Students turn copper pennies into gold.
Procedures:

1. Students bring copper pennies and clean them with steel wool. (The scratched surface also helps.) They must record the appearance of the penny.
2. Students soak the pennies in a NaOH and zinc powder solution for twenty minutes.
3. Students take the pennies out of the solution and record any changes in appearance. (Zinc and NaOH have coated the penny.)
4. Light the bunsen burners. The students hold the coated pennies, with tongs, over the flame for 10 – 15 seconds (or until a color change occurs). Be careful not to melt the penny.
5. Students should carefully observe the changes to the penny and record their data. (Pennies should be a golden color.)
6. Discuss why people might think the transformation is real. Ask the students to explain what happened.

Appendix F1: Cool Chemistry

Lesson Six: Atomic Bonds
When molecules are formed, the chemical bonds occur between valence electrons.
Usually the electrons are shared or are given/taken away.

Molecules are two or more atoms joined together by a covalent bond.

Chemical bonds are created when electrons of different elements combine.

Ionic bonds occur between a metal and a nonmetal. Nonmetals like to take electrons, and metals like to give up electrons.

Covalent bonds occur between two nonmetals. Nonmetals like to take electrons, but because neither wants to give up their electrons, the nonmetals share the electrons.

Noble gases do not give or take electrons. Their outermost electron level is full.

Lesson Six: Atomic Bonds Activities
Provide construction paper puzzle pieces to each student. Each piece should have one or two partners. (atom or molecule)

Each puzzle piece has an element symbol on it.

1. When the students enter the room, each student is given a piece of a puzzle. Metals will receive one or two pieces of candy, and nonmetals will receive one piece of candy.
2. On a piece of paper, each student must write the element name, element symbol, atomic number, atomic weight, number of protons – neutrons - electrons – valence electrons, and metal/nonmetal for his or her puzzle piece.
3. After the students have done this, the students must find their bonding partner. Their puzzle pieces have to match, and the partners must give, take or share their candy.
4. As a bonding pair, the students must draw what their new molecule would look like … emphasis on the sharing, giving, or taking of electrons.

Cartoon Activity
Assign elements to student pairs. The students must identify the element name, element symbol, atomic number, atomic weight, number of protons-neutrons-electrons-valence electrons, and metal/nonmetal status of each element.
Together the students must create a cartoon depicting the process of ionic or covalent bonding.

Appendix G1: Cool Chemistry

Lesson Seven: Balancing Equations
To explain how chemical reactions/chemical change occur, scientists created chemical equations.
Chemical equations use element symbols and numbers to represent chemical change.
Some equations use coefficients … numbers placed before an element or compound. Coefficients are multiplied with subscripts. Coefficients carry through a compound until a new compound or element is introduced (indicated by a + sign).
Subscripts are numbers placed below and after an element in a chemical equation. If no subscript is present, it is understood to be only one atom of the element.
When writing equations, scientists must follow the First Law of Thermodynamics … Matter cannot be created or destroyed; it can only change from one form to another. Equations must be balanced on either side of the yield sign.

Lesson Seven: Balancing Equations Activities
Students balance equations:

1. Select a symbol for each different element.
2. Count the numbers of each individual element.
3. Draw the correct number of symbols under the corresponding elements.
4. See if you have the same number of symbols in the product and reactants.
5. Add coefficients where necessary. (Do not add subscripts in this activity!)

Example:
(reactants) (products)
$2\ Na + Cl_2 \rightarrow 2\ NaCl$
** @@ ** @@

1. $N_2 + O_2 \rightarrow N20$
2. $N_2 + H_2 \rightarrow NH_3$
3. $H_2O_2 \rightarrow H20 + O_2$
4. $CO_2 + H20 \rightarrow H_2CO_3$
5. $K_2O + H_2O \rightarrow KOH$
6. $Mg + HCl \rightarrow MgCl_2 + H_2$
7. $KI + CL_2 \rightarrow KCl + I_2$
8. $Na + H_2O \rightarrow NaOH + H_2$
9. $KClO_3 \rightarrow KCl + O_2$
10. $K_3PO_4 + HCl \rightarrow KCl + H_3PO_4$

Magnesium and Vinegar Lab
Drop a piece of freshly sandpapered magnesium ribbon into a small amount of white distilled vinegar. The students should record this in their lab journal.
Magnesium + Acetic Acid (HC_2H_302)
When the magnesium and acetic acid react, they produce hydrogen gas and magnesium acetate forms on the metal strip.
$Mg(C_2H_3O_2) + H_2$

The students should place this information in the form of an equation. They must label all parts of the equation … coefficients, subscripts, product, reactant, yield sign … and balance the equation.

Appendix H1: Cool Chemistry

Lesson Eight: Oxidation and Reduction Reactions
Oxidation occurs when an atom loses an electron. Oxidation reactions commonly involve oxygen, and heat is given off because of the reaction

LEO or OIL
L – loses E – electrons O – Oxidation
O – oxidation I- is L - loss

** The atom becomes positive when electrons are lost because electrons are negative.
A common example of oxidation is the rusting of iron
Reduction occurs when an atom gains an electron. Reduction reactions usually take in heat.

GER or RIG
G – gains E – electrons R – Reduction
R – reduction I – is G - gain

** The atom becomes negative when electrons are gained because electrons are negative.

Lesson Eight: Oxidation and Reduction Activities
Oxidation of Penny Lab
Materials: lemon juice or vinegar, penny or copper coin, small cup
Procedure: Pour lemon juice or vinegar into cup. Place the coin in the cup and let it soak for five minutes.
Explanation: Oxygen from the air combines with copper to make a dull copper oxide coating.The acid of the lemon removes the oxide.

Bleach Oxidizer
Materials: two small cups, two small steel-wool balls, vinegar, bleach
Procedure: Place two steel-wool balls into separate cups. Cover the balls with equal amounts of water. Add a tablespoon of vinegar to one cup and a tablespoon of bleach to the other.
Explanation: After 30 minutes, the steel wool in the vinegar should be coated with rust. Rust is iron that has combined with oxygen that was present in the water.

Burning Metal
Materials: goggles, water, fine steel wool, pliers, matches
Procedure: Close the drain to a sink. Fill the sink with water until the bottom is barely covered. Grab the steel wool with the pliers and hold it over the sink. Light the steel wool with the matches.
Explanation: The steel wool burned and generated heat and light. (Just like what is generated when burning wood, paper, coal …) The heat and light indicate that energy was released. When the burning took place, oxygen in the air combined with the iron in the steel wool and changed the iron into iron oxide. The corrosion and burning of steel wool is oxidation.

Batteries
Materials: two steel nails, one lemon, two shiny pennies, small earphone
Procedure: Use a nail to make a slit in the lemon peel. Push a penny into the slit so that half of the penny is inside the lemon. Push the nail into the lemon about 0.8 cm away from the penny. Put the listening part of the earphone to your ear, and place the metal plug end across the penny and nail. You should hear crackling sounds.
Explanation: When you connected the copper with the steel nail, you made a battery. The acid in the lemon contains charged molecules that complete the nail and penny circuit. Electrons were transferred via the earphone plug. The negative terminal (nail) is where oxidation occurs, and the positive terminal (penny) is where the reduction occurs.

Appendix I1: Cool Chemistry

Lesson Nine: Acids and Bases

pH stands for percent Hydrogen. The pH scale measures the strength of acids and bases. The pH scale ranges from 0-14. Acids are 0-7. Bases are 7-14. Neutral substances are 7.
We measure the pH of a substance by using indicators. Indicators change color in the presence of acids or bases. A common indicator is litmus paper which turns red in the presence of acids and blue in the presence of bases.

Acids produce hydrogen ions when dissolved in water. They are corrosive and are very good at breaking things down … that's why they are in your stomach. Acids are also good conductors of electricity … that's why they are found in batteries.

Bases produce hydroxide ions when dissolved in water. They have a bitter taste, feel slippery, and can be corrosive.

Lesson Nine: Acids and Bases Activities
Provide the students with litmus paper and pH paper. Allow them to test a variety of substances. Dissolve solid materials in water and place in alphabet labeled containers. Have the students follow these steps.
1. Draw lines to divide a sheet of construction paper into ten equal boxes.
2. Label the columns: solutions, red litmus, blue litmus, change, pH color, pH number
3. Have the students test the solutions and record their observations. Based on a key you provide, see if the students can guess what acids and bases you used.

Have the students research acid rain. Based on their knowledge of chemical equations and acids, have the students explain the process of acid rain and its effects on our environment.

Antacid Activity
Materials: different antacids, beakers, goggles, HCl, water
Procedure: Crush the antacids and add them to 10 mL of water. Add five drops of Congo Red indicator. Pour acid into the antacid solution. Record observations.

You can test the pH of almost anything … have fun with it.

Appendix J1: Cool Chemistry

Culminating Activity – Red Eye for Snake Eye
Adapted from activity presented by Barbara Kerbo and Paulette Noble, Pampa, TX
Teacher reads the story and follows instructions provided

Once upon a time, many years ago, Snake Eye and his little brother came riding into town. They were two of the meanest, nastiest, and orneriest outlaws the West had ever seen … and to top it off, they had just been paroled from the Territorial Prison.

Old Snake Eye and his little brother were hot and thirsty from the long and dusty ride. They thought a visit to the Last Chance Saloon would fix them up. As they walked up to the bar, Snake Eye said, "Barkeep, give me a shot of Old Red Eye."
** Teacher pours ammonia/water mixture from pitcher into glasses 1 and 2, which have been prepared with two drops of phenylthalene.

Snake Eye and his little brother were standing at the bar sipping their Red Eye … getting meaner and nastier by the minute. Just then a little dude walked in and said, "Could I please have a glass of sasparilla?" So the bartender poured him a glass of sasparilla.
**Teacher pours ammonia/water mixture from pitcher into glass 3, which is empty.

The little dude, minding his own business, began to drink his sasparilla. Snake Eye and his little brother thought they would have some fun with him. They said, "We're drinking Red Eye, shorty. What are you drinking?" "Sasparilla," Little Dude answered. "Sasparilla," laughed Snake Eye. "Well, around here we drink Red Eye, and that's what we think you ought to drink too." So they all finished their drinks.
**Teacher pours all cups into the pitcher

Snake Eye said to the bartender, " A shot of Red Eye for all of us." So the bartender poured each of them a shot of Red Eye.
** Pour water from pitcher into all three glasses.

A few minutes later the Marshall entered the saloon and walked up to the bar and said, "Barkeep, I'll have a glass of sasparilla."
**Teacher pours water from pitcher into cup 4, which contains vinegar

It didn't take long for the Marshall to notice Snake Eye and his little brother and what they were up to. He said, "What are you two doing in here drinking Red Eye? You know that's a violation of your parole. I think we'll all have sasparilla."
**Teacher pours all four cups into the pitcher and then back into individual cups.

And that's exactly what they did.

During this activity many of the aspects of the chemistry unit are covered. After the presentation, ask the students what they think caused the change.

The students should be able to:
Identify the chemicals involved and name the elements, compounds, and mixtures
Identify the atomic number, atomic mass, element symbol, family, period of the elements

Identify what type of bonding occurred
Create a chemical equation and label the products, reactants, acids, and bases