Chemistry Notes

What is chemistry?

- The study of matter and it's changes
- Almost everything you see and use is chemical
- Chemistry is the central science that is used in biology, environmental science, anatomy, etc..
- A basic knowledge of chemistry and the other sciences is becoming more important in our modern society
    - stem cell research
    - genetic engineering and cloning
    - oil prices
    - alternative fuels
- Since chemistry covers such a wide range of subjects, it is often subdivided into branches. These are some common branches:
    - organic – carbon containing compounds found in living things
    - inorganic – anything that is not organic
    - physical – atomic behavior a matter and energy
    - biochemistry – chemistry of biological processes

Scientific Method

Demo – Inductive lab

- Is there a chemical difference between tap water and soda water?
- What do you think?
- What do we call drinks that fizz? (carbonated)
- Using the information we have, what should we test for?
- If you were a chemist, then you would know how to test for carbonate. We are going to add $CuCl_2$ to test for carbonate.
- What happened to the tap water?
- What happened to the soda water?
- What can we conclude from this?
- How sure are you about your conclusion?
- How can you become more secure about your conclusion?
- What would we have to do if this test did not work?

You have just been working through the scientific method. What are the steps of the scientific method that we used?

- Observation
    - prior knowledge, qualitative data, and quantitative data
- Hypothesis
    - A tentative explanation of what is observed
    - must be testable to be valid

- Experiment
    - A set of controlled observations used to test the hypothesis
    - Independent variable – the variable you are changing on purpose
    - Dependent variable – the variable that you are measuring as a result
    - Control – everything else
- Conclusion
    - A possible explanation for the results of the experiment
    - Even if it agrees with the hypothesis, it does not "prove" it and is just a possible explanation
    - If it proves the hypothesis to be false, then you have to come up with a new hypothesis and do another experiment
- Theory
    - An explanation supported by many experiments
    - They express principles that have been supported over time, but they are always open to new interpretations when new data is found
- Law
    - Describes a naturally occurring event that is supported by many experiments
    - Does not try to explain why or how it happens, so it is NOT a stronger form of a theory
    - The law of gravity – always works, but no one knows how it works

Scientific Research

There are two primary methods for using the scientific method in chemistry.

- Pure research
    - Its goal is knowledge
    - Driven by curiosity about how or why something happens
- Applied research
    - Its goal is understanding or solving a specific problem
    - Driven by a societal need
- Both pure and applied research can result in chance discoveries – some important discoveries have been by accident
    - penicillin
    - nylon
    - post-it notes
- The byproduct of research that is applied to our lives is called technology

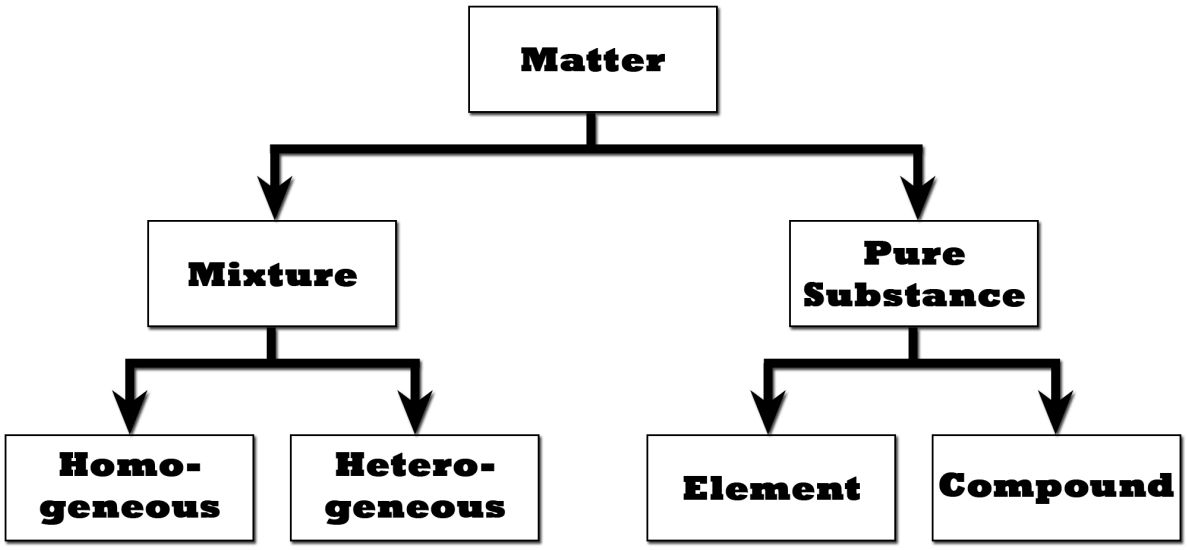
Describing Matter

- Matter is anything that takes up space and has mass
    - What in our room is matter?
        - solids, liquids, gases
        - even small things we can't see like bacteria and viruses
    - What in the room is not matter?
        - light, sound waves, heat

- An object can have either physical or chemical properties
    - physical – describes the object as it is [How can I describe a piece of paper as it is? – color, shape, size, weight, etc.]
    - chemical – describes how the object can change it identity [How can I change a piece of paper's identity? – burn it]
- An object can undergo either physical or chemical change
    - physical – change where the identity of the object remains the same [How can I change the paper but not change its identity? – tear it, fold it]
    - chemical – change where the identity of the object changes [How can I change the paper so that its identity is also changed? – burn it]
        - A chemical change is usually called a chemical reaction

Classifying Matter

The flow chart below shows how matter is classified.



- [What is the basic building block of all matter?] All matter is made up of atoms.
- Atoms make are the building blocks for all the types of matter. The simplest form of matter is an element. An element contains only one kind of atom. [What are some examples of elements?]
- Atoms from different elements can be chemically combined to form a compound. The process of chemically combining the elements changes their identities into the new identity of the compound. [What are the properties of hydrogen and water? How do they differ from water or even hydrogen peroxide?]
- Elements and compounds are called pure substances. A physical combination of pure substances will make up a mixture. A mixture can be physically separated (filtering, sorting, distillation, etc.). Mixtures are divided into two groups.
    - A homogeneous mixture is a mixture that is uniform throughout. A can of coke is a good example. No matter where you take the sample from in the mixture,

the sample will be exactly the same. A homogeneous mixture is often referred to as a solution.
    - A heterogeneous mixture is not uniform throughout. An Oreo Blizzard from Dairy Queen is a good example. Each spoonful will be a little different.
    - [Tell me if each of the following is homo or hetero. sweet tea, a salad, bronze, air, chocolate chip cookie]

Elements

- In ancient times, people thought that everything was made of just a few simple elements
- Modern science defines an element as a substance that cannot be separated into simpler substances.
- The elements are listed on the periodic table
    - Names come from tradition, scientists, countries, states, or even planets
    - Symbols are one or two letters
    - If there are two letters then the 1st is capitalized and the 2nd is lower-case
    - Some weird symbols are derived from the ancient name for that element
        - Na – sodium (natrium)
        - Fe – iron (ferrum)
        - Au – gold (aurum)

Compounds

- Usually abbreviated cpd
- A compound is a substance that is made of a fixed ratio of elements
    - Water – H_2O – 2 hydrogens and 1 oxygen
- Use element symbols to write the "formula" for the compound
- It can be difficult to distinguish between a pure element and a pure compound
    - Both are pure substances with set properties
    - How do you determine which is the simplest elemental form
        - Make observations about chemical reactions
            - Mg and MgO
        - Electrolysis – applying a strong electrical current will often cause the chemical bonds in a compound to break to form the basic elements

Mixtures

- Substances that are not pure are called mixtures. They are a blend of two or more pure substances
- There are two types of mixtures
    - Homogeneous
        - Often looks like a pure substance
        - Has a uniform composition throughout the sample
        - Also called a solution
        - Ex – Coke

    - Heterogeneous
        - Not uniform throughout the sample
        - Ex – Dairy Queen Blizzard
- There are a variety of methods for separating mixtures
    - Filtering
        - Used for heterogeneous mixtures of liquids and solids
        - Pour the mixture through a filter to trap the solid particles
        - Ex – Coffee filter
    - Distillation
        - Used for homogeneous mixtures of liquids with different boiling points or for a liquid-solid solution
        - Heat the sample so that the liquid with the lower boiling point will evaporate first. Collect the vapor to recover the liquid.
        - Ex – moonshine, desalination
    - Crystallization
        - Used for liquid-solid solutions
        - Crystals form as moving or evaporating liquids leave the dissolved solid behind on some surface
        - Ex – stalactites, rock candy, gems
    - Chromatography
        - Used to separate solutions
        - Parts of solution separate as they are carried along a stationary substance by a solvent.

Energy

- Usually abbreviated with a capital E
- the capacity to do work or to produce heat
- Work – the capacity to move an object over a distance against a resisting force
    - *What are some examples of work?*
- *What are some types of energy that you know of?*
- We will use three major types of energy
    - Radiant – energy from waves
    - Kinetic – energy of motion
    - Potential – stored energy
- Radiant energy
    - Comes from waves – usually electromagnetic in origin
    - Examples – sun, light, UV, x-rays
- Kinetic energy
    - Examples – moving car, thrown ball
    - 2 sub-types
        - Mechanical – from moving mechanical parts – engine
        - Thermal – from moving particles in matter – hot stove, heater

- Potential energy
    - Stored energy from position or arrangement
    - 3 sub-types
        - Gravitational – when gravity converts the potential E into kinetic E – falling apple, roller coaster
        - Electrical – when different charges are present – battery
        - Chemical – stored in chemical bonds – fuel, food
- There are two main units for measuring energy
    - The common unit is the calorie (cal) – 1 cal = heat to raise temp of 1 g of water 1 oC
    - In nutrition, they use a dietary calorie (Cal) – 1 Cal = 1000 cal
    - The SI unit for energy is the Joule (J) – 1 cal = 4.18 J
- Law of conservation of energy
    - Energy is neither created nor destroyed
    - Ex – hitting a baseball, roller coaster, bouncing ball
    - Exception – nuclear reactions – $E = mc^2$

