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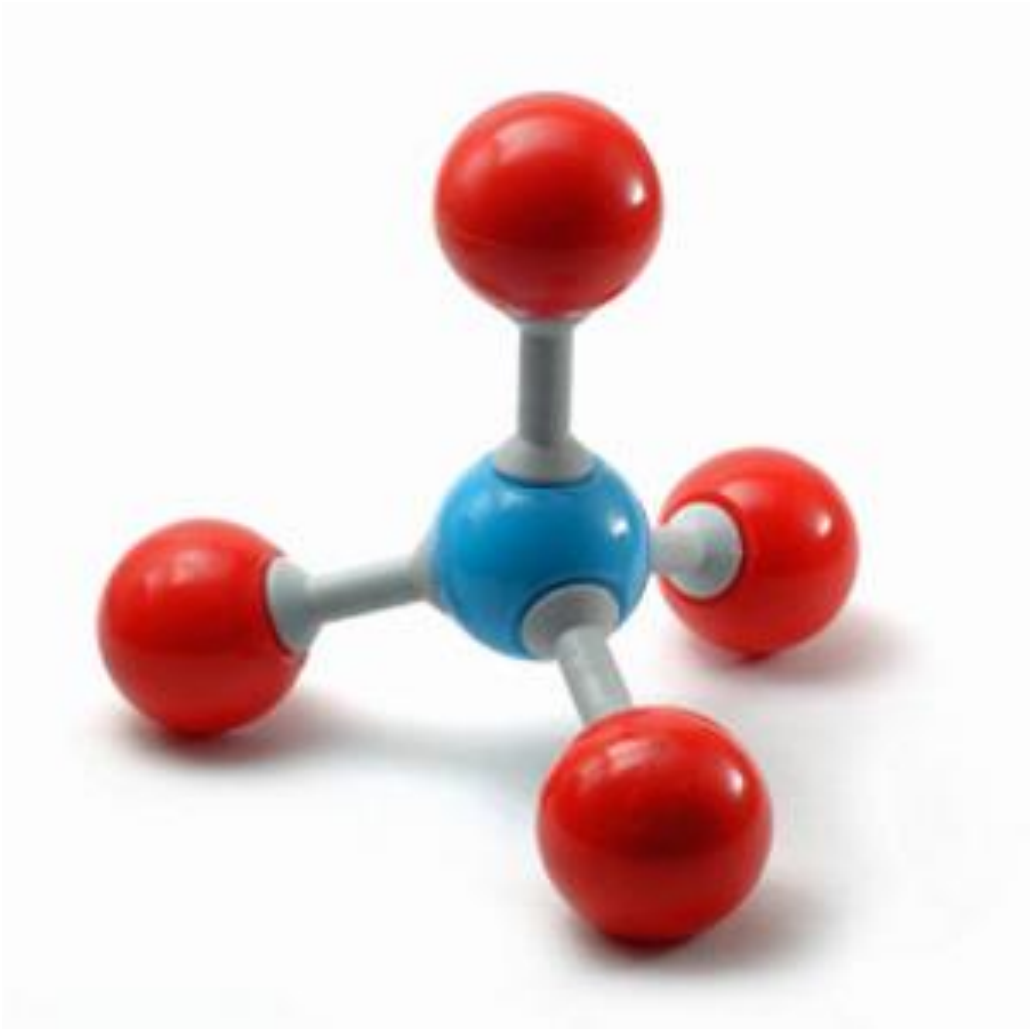
Lawrence High School's CP/Honors Chemistry 2021 Recommended Jumpstart **Summer Reading Assignment**



To incoming CP and Honors Chemistry Students:

To be best prepared for Chemistry in September, you have been provided with a suggested summer reading packet. The purpose of this reading is two-fold. The first is to serve as a refresher for various skills to which you should have already been exposed. The second purpose is to serve as a preview of what is to come. Most, if not all of you are entering this class after completing biology. This class is VERY different from biology. It is both a science class and a math class. In fact, math is the language through which chemistry is explained.

Suggested assignment: Please read the information on the following pages to get acquainted with topics and concepts you are about to learn in Chemistry this coming school year!

Optional assignment: Highlight terms in the passages that you may already know or recognize from previous science courses. If you are not able to print this document, create notecards or a Google doc with topics that you are familiar with. These notes can be used to spark conversation with your Chemistry teacher and/or peers once school begins.

Good luck with this reading and enjoy your summer!

Ms. Andahazy
Mr. Marbach
Ms. Zuczek

Table of Content:

Notes & Examples: Keep this for your reference for the entire school year.

1. *Variables*

The scientific method often employs the use of *variables* to carry out a particular study.

There are two types of variables:

- The ***independent variable*** is the variable that is being changed in the procedure. (*the cause*)
- The ***dependent variable*** is the variable that is being affected by the change in the independent variable (*the effect*)

- A ***control*** is often used as a comparison to the independent variable.
    - This serves as the "normal situation" for a given sample or situation.

Example: Enrique and Lacey are testing soil for contamination outside a nuclear power plant. They test the concentrations of contaminants at different distances from the plant.

1. What is the independent variable?
   The distance from the plant. (Lacey and Enrique select the distances to test)

2. What is the dependent variable?
   The concentration of contaminants (this is the data they will collect & the factor will depend on how far they are from the plant)

3. What are some factors that Enrique and Lacey will keep constant?
   Test using the same equipment, test soil at the same depth in each location, test from the same power plant, test the same time of day, etc.

2. *Graphing and Data Analysis*

Graphs are a useful tool for displaying scientific data because they show relationships among variables in a compact, visual form. You may have used *x-y* graphs in your math classes. Below are the four basic steps to constructing a graph from data in the chemistry lab.

1. *Determining the variable*
   - In an experiment, the ***independent variable*** is the property that is under control and can be varied.
   - The ***dependent variable*** is the property that is measured, observed, counted, or found.

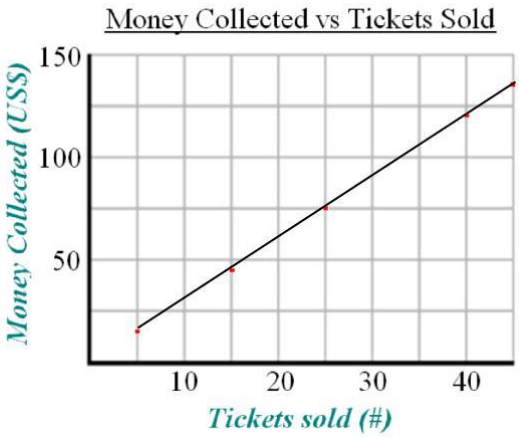
2. *Scaling the axes*
   - The scale of the axes includes all data points and allows as much room as possible on both axes. Each axis should be evenly divided with plenty of space between divisions, making the graph easy to read and understand.
   - Each axis should also be labeled with a description of what it represents and the units of measurement.

3. *Plotting the data*
   - If the plotted data points roughly form a straight line, you may need to draw a ***best-fit line***.
   - If the points do not form a straight line but appear to form a curve, sketch the curve connecting all the data points.

4. *Titling your graph*
   - It is important to add a title to the top of your graph, so that anyone looking at the graph can easily identify its purpose. Choose a title that is brief and descriptive of the data.
   -

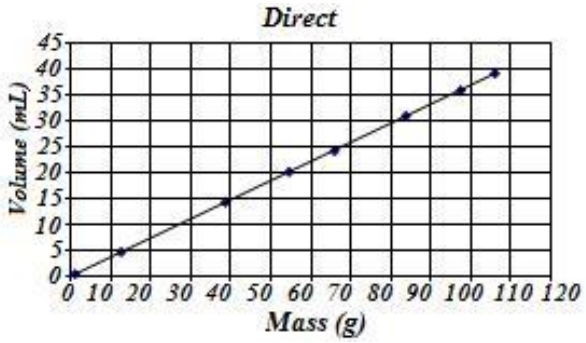
<u>Example:</u> Your school is putting on a play. To raise money for the event, tickets for the play are being sold for $3.00 each. The chart below shows how much money will be made from selling certain numbers of tickets.

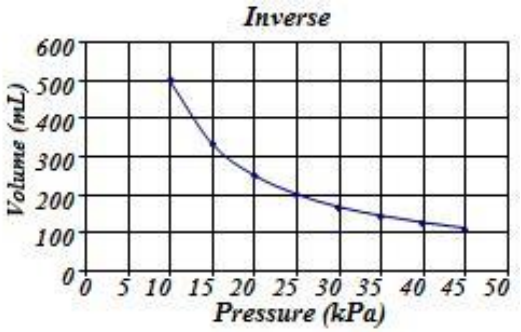
Tickets sold	*Money collected*
5	$15
15	$45
25	$75
40	$120
45	$135



Graphs show the relationship between *x* and *y* variables.

- If data forms a straight line when plotted, then *x* and *y* have a **linear relationship.**
- This line can be described by the general mathematical equation $\boldsymbol{y = mx + b}$ where $\boldsymbol{m}$ is the slope of the line and $\boldsymbol{b}$ is a constant.
- Linear data is said to be **directly proportional** when dividing one variable by the other gives a constant value. This means that as one variable changes, the other changes at the same rate
- Not all data forms a straight line when graphed; your graph may show a curve.
- If the curve drops as you move from left to right, and dividing one variable by the other gives a constant reciprocal value, then your graph has an **inverse relationship.**





Many types of graphs exist: line graphs, bar graphs, pie charts, histograms, etc. In order to display the results of the experiment appropriately, the right type of graph should be used.

- A line graph is used when the independent variable changes in regular increments and must be placed in a specific order. Points are plotted and then connected.
- A bar graph is used when the independent variables can be placed in any order.
- A histogram is a type of bar graph used when the data involves the frequency of occurrence.

3. *Density calculations*

Mass is a measure of the amount of matter in an object. - how much "stuff" is inside an object.

Weight is the force that mass has as a result of gravity.

- When the gravity changes, the weight will change, but the mass will remain constant

Volume is the amount of space an object occupies. - remains constant for solids and liquids.

Density is the amount of matter per the amount of space. It is calculated by dividing the mass by the volume.

- Density is an intensive property; it will remain the same no matter how much of the substance there is.
- The density of an object will determine if it will float or sink in another phase. If an object floats, it is less dense than the other substance. If it sinks, it is denser.

The formula for density looks like a heart with a line through it: **D =**  $\mathbf{D=\frac{m}{V}}$

Example: What is the volume of a substance with a mass of 75.8g and a density of 7.87 g/cm^3?

$$7.87\,g/cm^3 = \frac{75.8\,g}{V}$$

1. **Input the information provided in the problem into the formula for density:** $\mathbf{D=\frac{m}{V}}$

$$V\left(7.87\,g/cm^3 = \frac{75.8\,g}{V}\right)$$

2. **Multiply through by "V"**

$$V\left(7.87\,g/cm^3\right) = 75.8\,g$$

$$\frac{V\left(7.87\,g/cm^3\right)}{7.87\,g/cm^3} = \frac{75.8\,g}{7.87\,g/cm^3}$$

3. **Divide both sides by 7.87 g/cm^3**

$$V = 9.63\,cm^3$$

4. Describing Matter

Matter is anything that has mass and occupies space (has volume).

Property- a quality that serves to describe

- **Physical property** – a quality that can be observed without changing the identity of the substance (ex. color, shape, density, melting point)
- **Chemical property** – a quality that, in ordered to be observed, requires the substance to change chemically (ex. flammability, reactivity)
- **Intensive property** – a quality that does NOT change when the quantity of the substance changes (ex. density, boiling point, melting point, flammability)
- **Extensive property** – a quality that DOES change when the quantity changes (ex. volume, length, width, number of particles, mass)

Change – an action that alters the substance in some way

- **A physical change** – an action that does NOT alter the chemical make-up (changes the chemical composition or the chemical formula)

A change of state is a physical change from state to another

– Melting, freezing, vaporization, condensation, sublimation, deposition are the processes that change one phase to another.

- The phases are:
  - **Solids** have definite volumes and definite shapes - tight rigid structure
  - **Liquids** have definite volume and variable shapes - particles slip past each other.
  - **Gases** have variable volume and shape - particles not strongly attracted to each other.
  - A fourth phase, **plasma**, also has variable volume and shape
    - ✓ It is a high temperature physical state of matter in which atoms lose their electrons.
    - ✓ Not found very often in nature
- Creating any form of mixture is also a type of physical change along with crushing, tearing and magnetizing

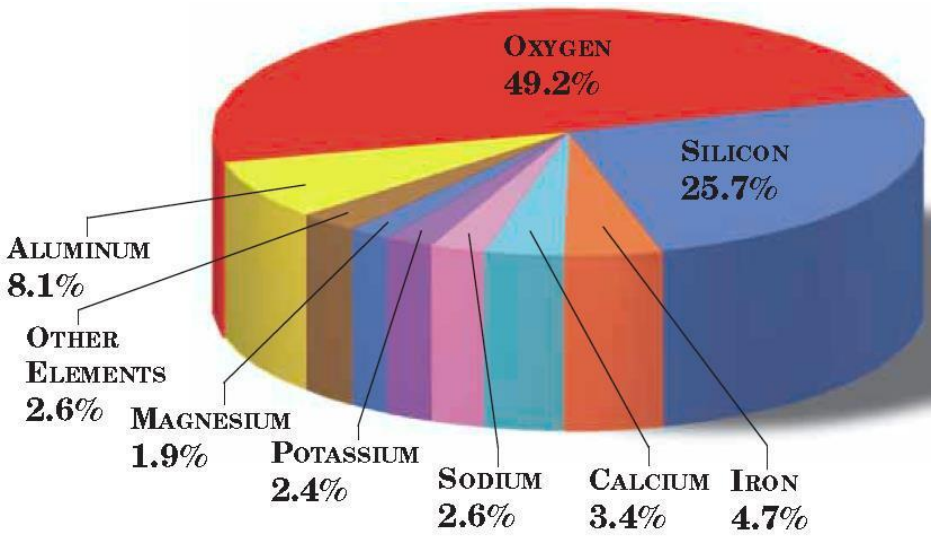
- **A chemical change** – an action that DOES alter the chemical make-up (changes the chemical composition or the chemical formula)
  - *Reactants → products*
  - **Exothermic** reactions liberate (release) energy
  - **Endothermic** reactions require (absorb) energy

- **Indicators of a Chemical Change**
  - Production of a gas (production of bubbles, odor, gas)
  - Production of a precipitate (production of an insoluble solid)
  - Production of thermal energy (gain or loss of heat)
  - Production of light
  - Permanent color change
  - **Combustibility,** a specific type of chemical change in which any substance rapidly reacting with oxygen producing light and heat.

Elements, Compounds, and Mixtures

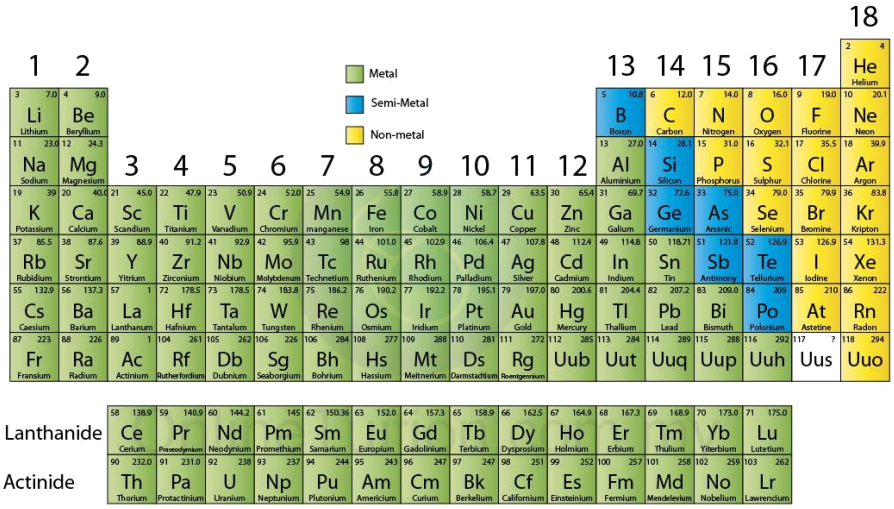
An **element** is a type of pure substance that cannot be broken apart into its components.
At this point in time, there are 118 elements.
Of those, about 90 to 98 exist naturally on Earth, once again, depending on your source.

- The Earth's atmosphere is about 78.1% N_2, 20.9% O_2, 0.9% Ar, and CO_2, He, Ne, CH_4, Kr, and H_2 round out the remaining 1% by the relative abundance of each.
- The breakdown of the Earth's crust is in the diagram below.
- The single unit of an element is the atom, which is the smallest unit of an element that maintains the properties of that element.
- For the diatomic elements (Hydrogen, Oxygen, Nitrogen, and the Halogens (group 17), the single unit is the molecule, which means that it has two atoms combined (H_2, O_2, N_2, F_2, Cl_2, Br_2, I_2).
- Two other molecular elements are sulfur (S_8) and phosphorus (P_4).



The **periodic table**

- Vertical columns are known as **groups** or **families**.
  - There are 18 of them
- Horizontal rows are called **periods**
  - There are 7 of them



The Periodic Table is divided into two sections by the "staircase".

- To the left of the staircase are all the **metals**.
  - This includes the two rows at the bottom (the Lanthanides and the Actinides).
  - Does not include hydrogen
- To the right of the staircase are the **non-metals** (including Hydrogen).
  - The properties of nonmetals are the opposite of metals.
- **Metalloids** are the elements that compose the staircase between metals and non-metals.
  - Properties are a blend of metal and non-metal.

Metals:

- have **luster** (shine)
- have **ductility** (ability to be drawn into long pieces of wire)
- have **malleability** (the ability to be flattened by a mallet into sheets)
- have the ability to conduct heat and electricity.
- are solid at room temperature.
  - The exception is mercury, which is a liquid at room temperature.
- will lose electrons when they become positive ions.

Nonmetals:

- are dull (they do not have shine)
- are brittle (they cannot be formed into wires or sheets)
- are non-conductors
- can be solids at room temperature
- can also be liquids, as in the case for bromine
- can be gases (hydrogen, nitrogen, oxygen, fluorine, chlorine, and the noble gases (group 18).
- will gain electrons to form negative ions.
  - The addition of a negatively charged particle yields them a negative charge.
  - Some nonmetals, the ones that do not gain electrons, will not form ions at all.

Metalloids are elements that have characteristics of the previous two.

- There are seven: boron, silicon, germanium, antimony, arsenic, tellurium, polonium
- Sometimes astatine is included bringing the total to eight

Compounds, like elements, are pure substances.

- Pure substances cannot be broken down by physical means.
- Every particle in a pure substance has the same properties.

Compounds are different than elements in many ways also.

- 1) Made up of two or more types of elements. 2) Can be broken apart by chemical means.

Mixtures contain two or more substances that are not chemically combined, and therefore, can be separated by physical means.

- Sugar water is a mixture. The sugar and water can be separated by boiling off the water.
  - Both components will still retain their properties after separation. Neither will change.
- Brass is a mixture of copper and zinc; separation based on differing melting points

Mixtures can be separated by several different physical means.

- **Distillation** is a process similar to boiling where the substance that evaporates is captured and condensed; it uses differences in boiling point.
- **Filtration** is a process that uses particle size.
  - Smaller particles pass through the pores in the filter, while the larger particles stay behind.
- A **centrifuge** can be used to speed the process of separating substances by density.
  - More dense particles will sink to the bottom.
- **Chromatography** is a physical process that uses the stationary and moving phases of substances.

1. **Homogeneous** mixture is uniform in composition
   - **Solutions –** mixture parts are so small they cannot be seen by the human eye or a microscope.
     - Composed of a **solute** dissolved into a **solvent**.
     - **Alloys –** mixtures of metals (examples include: brass, bronze, and steel)

2. **Heterogeneous** mixtures are not uniform in composition

5. Chemistry as a Science

It began from **alchemy**

- A pseudoscience known for its attempt to change common metals into gold

Roger Bacon

- Suggested using observation and experimentation rather than pure logic or trial and error to explain natural phenomena.

Antoine Lavoisier

- He made precise measurements of mass changes during chemical reactions.
- He is often referred to as the founder of modern chemistry because of his emphasis on careful experimental measurements

Chemistry is the study of the composition, structure, and properties of substances and the changes they undergo.

- A chemical is any substance with a definite composition.
- All matter has a chemical basis whether it is living or nonliving.

Divisions of Chemistry

There are at least 25 specialty areas of chemistry, but each one can be classified under one of the following six major divisions or branches of chemistry, which can often times overlap.

1. **Organic chemistry:** the study of most carbon-containing substance
   - *Example:* how gasoline is produced from oil
2. **Inorganic chemistry:** the study of all substances not classified as organic, mainly those that do not contain carbon
   - *Example:* how table salt reacts with different acids
3. **Analytical chemistry:** the study of the identification of the components and composition of materials
   - *Example:* how much chlorine is in a sample of tap water
4. **Physical chemistry:** the study of the properties, changes, and relationships between energy and matter at the atomic scale
   - *Example:* how the size of a water molecule determines the rate at which it dissolves salt
5. **Biochemistry:** the study of substances and processes occurring in living things
   - *Example:* How sugar in the blood stream of cats affect insulin production
6. **Theoretical chemistry:** use of math and computers to understand chemical behaviors and design new compounds
   - *Example:* Modeling the folding of a protein

Types of Research

1. **Basic research** is done to increase knowledge (ex: examine all the reactions involving water)
2. **Applied research** is done to solve a problem (ex: investigate the side effects to a new drug)
3. **Technological development** is done to improve quality of life

   Technology is the application of knowledge for practical purposes.

Model - commonly used to help visualize atoms and molecules.

- Chemists' models of atoms and molecules are much larger than the real thing.
- Models can be mathematical or even imaginary.