Unit 1: Nature of Chemistry
Content Outline: Review of the Scientific Method (1.2)

I. The Scientific Method
   A. Observation
      1. This observation of something in nature leads you to a *question* such as "Why or How did that happen?" or "What if…?"
      2. *Types* of observations in science:
         a. **Qualitative** (sounds like quality)
            i. These are *qualities* (descriptions) that an object possesses, such as color, shape, and texture.
         b. **Quantitative** (sounds like quantity)
            i. These are numbers dealing with *amounts* of an object(s), such 9 bowling balls, ½ of a cake, 2 quarters and 3 dimes.
      3. *Areas* of observation in science:
         a. **System** – a *specific* portion of **matter** (anything with mass and takes up space) in a *given* region of space that has been *selected for study* during an *experiment*.
            i. **Open system** – this type *interacts* by *exchanging matter or energy* with the surroundings.
            ii. **Closed system** – this type *does NOT interact* with the surroundings. There is *NO exchange* of matter or energy.
         b. **Surroundings** – areas *outside* and *surrounding* the system.
         c. An example would be you (the open system) surrounded by the air and environment around you (surroundings).
         d. An example of a closed system would be almost any lab exercise done in a *controlled lab environment.*
   B. Research
      1. You look through textbooks, scientific journals, and maybe on the Internet to see if you can find an *acceptable and logical* answer to your question.
         a. If you cannot find an *acceptable answer*, then you might *design* an experiment to test your question and hopefully find an *acceptable* answer to your question.
   C. Formulating a Hypothesis
      1. A **hypothesis** is an *educated* (because you have performed some *prior research*) *guess* about the *possible outcome* of an experiment, such as the one you developed.
         a. It may get proven or it may not. If it is not proven, then you might need to redo or modify your hypothesis <u>and</u> *then retest it*.
         b. It needs to be an "If … then" statement, such as "If water boils at 100°C, then we should be able to heat and measure water on a stove to prove this."
            i. The "If portion" is your initial question.
            ii. The "then portion" is your educated guess about the outcome of the experiment.
         c. Your hypothesis <u>must be testable.</u>
   D. Procedure of the experiment
      1. You must have a *step-by-step descriptive* procedure for your experiment.
         a. You must list quantities of items, such as chemicals, temperatures, or time.
         b. You must also state all the equipment needed to perform the experiment in each step.
   E. Experimentation and Data Collection
      1. This is the actual *performing* of the experiment using the *procedure* you developed.
      2. You need to be making **quantitative** and **qualitative** observations the *entire* time your experiment is being performed.
         a. To help keep the data in an organized, easy to understand format, you need to construct **data tables**.
            i. Data tables usually tell us information such as the Independent variables, Dependent variables, and constants.
               α. **Independent (controlled) Variable** – this is the part of the experiment you are *controlling, but modifying*, to see *if* it has an *effect on the outcome* of your

experiment. Some examples would possibly be: temperature, time, concentration.

b. **Dependent (changing) Variable** – this is the outcome you are measuring. It is *dependent* upon the outcome of your experiment. It *may* change *as you modify* the Independent variable being tested. Some examples would be: number of bubbles produced, % change in decomposition, or change in color.

c. **Constants –** These are conditions that are the same (uniform) for all parts of the experiment. They are *kept constant and unchanging*.

b. Data tables allow you to measure your accuracy, precision, and percentage of error.
   i. **Accuracy** – the *closeness* of measurements to a *correct or accepted value*.
   ii. **Precision** – the *closeness* of measurements to the *same* quantity. The quantity *may or may not be the accurate value, though.*

3. You must perform the same *exact* experiment *several* time to ensure your accuracy as it *will* be tested by your peers (other scientists) to see if you are telling the truth!

F. Analysis

1. This is where you will look over and think about your results.
2. At this point you will begin making graphs and calculations from your data tables and observations that you collected during the experiment.
   a. **Percentage error** – the mathematical difference (value) between what you *observed* and what *was expected.* Measured using the below equation:

$$\% \text{ Error} = (V_{Observed} - V_{Expected}) / V_{Expected} \times 100$$

Here, V represents any value that is being measured. The closer your percent error gets to zero, the more it becomes a perfect outcome; *not a perfect experiment.* The farther away from zero, the *worse* your results are.

3. You will begin theorizing (trying to prove) your hypothesis and backing it up *descriptively* using your collected data, graphs, calculations, and making models.
   a. **Theory** – a broad generalized statement that *attempts* to explain a body of facts or phenomena.
      i. These *can change* over time as *new data* comes to light.
   b. **Scientific Law** – These "never" change, as the outcome is always the *same*. For example, Newton's Law of Motion – an object remains in motion until acted upon by another object.
   c. **Model** – these are structures or formulas used for representing hard to see or hard to understand concepts. For example, it is hard to see the Solar system; but you probably made a model of it back in the 6th grade.

G. Publishing

1. This is were you will communicate the findings/outcomes of your experiment so that others can peer review/reproduce (to see if you are accurate) your work or use your work to expand their work.