Name: _____ **Date:** _____ **Class Notes**
Chemistry

What is Chemistry?

"Chemistry is the scientific study of matter, its composition and its changes."

Chemistry is the scientific study of matter, its composition and the changes it goes through. Thus, you need to understand what science is, how matter is composed and how matter changes if you are to be successful in chemistry.

First, you will start by learning the description of science, how to use the scientific method and the experimental process. Then, you will learn the divisions of matter, the states of matter and its properties. Also, during this time you will learn to use the metric system, how to record scientific information and perform conversions.

Once you have covered the basics, you will discover the composition of the atom and the mysteries of quantum mechanics. It is especially important that you understand the role of the electron in chemical bonding, molecular structure and chemical reactions. Then using this knowledge and the 7 secrets of the periodic table, you learn to name hundreds of chemicals, how to write chemical formulas and determine how reactions occur.

Most of all, you need to remember that chemistry is an active process not a static one. You need to look at the world around you, ask questions and test everything. The joy of science is discovering how!

"To deny, to believe, and to doubt absolutely -- this is for man -- what running is for a horse." - Blaise Pascal

Think About It

- What is Chemistry?

The Branches of Chemistry

- Inorganic
- Organic
- Biochemistry
- Analytical
- Theoretical
- Physical

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What is Science?

"Science is the systematic observation of natural phenomena."

In the early years, science was referred to as **natural philosophy** and the scientist was known as a **natural philosopher**. It was viewed as philosophy because it involved observing, thinking and hypothesizing, but not much in the way of testing or verifying ideas.

Thus, many ideas were accepted even though the ideas had not been thoroughly tested. This lack of testing created numerous false conclusions and a loss of credibility for natural philosophers.

Then in the late 1500's Francis Bacon developed a system of study to help natural philosophers become more objective. This new system of study, known today as the **scientific method**, not only involved observing, thinking and hypothesizing but also included experimenting. With the addition of testing to natural philosophy, it became more reliable and so began the new study of science.

But if the scientific method is so simple and logical, why was it such a staggering idea when it first appeared? It was so stunning because it was a complete reversal of how philosophers viewed things for centuries. For the first time in history an intellectual pursuit, besides math, would be required to prove its ideas.

The Scientific Method

"The scientific method is the process of science."

Science is the observation and description of natural phenomena and the scientific method is the process of science. So, you must understand how to use the scientific method if you are to truly comprehend science.

The scientific method is a step by step formula for proving that scientists' ideas are indeed correct. Although there are many versions to the scientific method, most follow a basic pattern with certain basic steps.

These steps start with an observation or an idea that leads to a hypothesis that can be tested. Then, the data collected from the tests can be analyzed to determine the validity of the hypothesis. If the hypothesis is correct you write a conclusion that explains your findings and defends your hypothesis. But, if your data shows your hypothesis to be incorrect you must rethink your hypothesis.

Science is a collection of ideas proposed by man and man is not perfect. As a result, science is bound to have errors, some intentional and some not. But, these errors can be minimized by a continuous application of the scientific method.

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The scientific method is the process of science and has brought to science a certain amount of respectability. But, it didn't solve all the problems. A scientific conclusion still relies on the scientist to interpret the data that is collected and the interpretation will reflect the worldview of the scientist.

Basic Steps of the Scientific Method:

- Observe
- Hypothesize
- Test
- Analyze
- Conclude

Worldviews

A **worldview** is what every person uses to interpret the world that surrounds him or her, and it develops from the philosophy a person chooses to embrace. The philosophy a person chooses depends on his or her convictions and these convictions are processed from what a person believes to be true. And, this so-called truth is ultimately based on assumptions that have been accepted without proof.

These assumptions, usually referred to as p**osits**, are found in all worldviews (aka belief systems). You will not find one belief system that doesn't assume something.

If worldviews are ultimately based on statements accepted without proof, scientists must try to eliminate as much of their worldview from the interpretation process as possible. They must follow the scientific method and leave their feelings out of the process. But, this is easier said than done.

Biases

When a person examines experimental data, he or she has certain predetermined ideas that are going to influence how the data is interpreted. These predetermined ideas, known as **biases**, cannot be helped because the examiner has posits that he or she has accepted by faith. For that reason, the examiner cannot be completely objective because of his or her faith.

No matter what scientists may say, all scientists are biased. And, it is for this very reason that the scientific method is so important. The scientific method helps to maintain the objectivity of science by imposing limitations on what is truly scientific.

Limitations

Science is defined as the systematic observation of natural phenomena. This definition is a direct result of the scientific method, which relies on observing,

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hypothesizing, and testing to provide an answer based on the data. The scientific method creates definite limits for scientific inquiry because good science must satisfy three conditions. Science must be:

- observable
- measurable and
- repeatable

Therefore, science cannot define moral decisions, verify truth or prove universal statements (all, always, never etc). A constant use of the scientific method will remind the scientist that science has limits and he or she must stay within those limits. If the scientist chooses to step outside of these limits then his or her hypothesis is no longer science, it's their opinion.

Workability

It is hard to think of science as truth because of its limitations and the reality that it is constantly changing. What is a scientific fact today may or may not be a fact tomorrow. So, why even bother with scientific study? We should bother with science because it is **workable**. Science properly used allows us to understand how (not why) things around us work. These workable discoveries have led to better health, better living conditions and better **technology**.

However, there are still many uncertainties in world of science and we cannot allow ourselves to believe that science is an absolute. Science is no more than a workable tool.

> *"Science is simply the observation and description of natural phenomena and anything more than this is philosophy."*

The Experimental Process

The third step of the scientific method is to **test** the hypothesis. The experimental process is the method used to test these ideas. So, it is important to understand how experiments are designed and how data is collected.

The experimental process begins with defining the problem and putting it down on paper. Once the problem is defined, you must determine the **controls** and the **variables**. The controls are the elements of the experiment that remain the same and the variables are the elements that are changed and manipulated during the experiment.

In any experiment there are two types of variables, the independent and the dependent. The **independent** variable is changed by the scientist not the conditions of the experiment and a good experiment will only have one independent variable.

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The **dependent** variable is changed by the conditions of the experiment. The scientist must monitor, observe and record how the dependent variable reacts to the changes in the independent variable.

Once the variables and controls have been defined, the scientist must perform the experiment. It is critical the scientist pays attention to details and keeps very accurate records. The information recorded at this stage is the **data** and it should be both correct and precise. There is no room for shoddy or careless work in the laboratory.

Data

There are two types of data: **qualitative** and **quantitative**. Qualitative data consist of words and cannot be measured. Colors, tastes and appearances are types of qualitative data. Data collected in this form is used in the early stages of research but is too subjective to use in the final stages.

Quantitative data can be measured and consist of numbers. Length, weight and time are all examples of quantitative data. This type of data is used in the latter stages of research because it allows the researcher to remain objective.

Although both types of data are important, quantitative is more efficient, more reliable and less likely to be misunderstood than qualitative data. But qualitative data is far more descriptive and harder to generalize. So, both types of data are necessary for the research process.

"There's no such thing as qualitative data. Everything is either 1 or 0."
- Fred Kerlinger

Conclusion

Now, the data must be organized and analyzed. Scientists use tables and charts to organize their data, and then use graphs, equations and statistics to analyze their data. Much of the time this is a very time consuming task, but it is the proof scientists must have to support their conclusion.

After the data has been analyzed, the scientist must interpret the results and write a conclusion. The scientist's conclusion should state what the problem was, whether it was solved and how the data supports the solution.

Finally, the scientist will publish the conclusion and the supporting data in a scientific journal for all scientists to read. The scientist's work will be repeated, tested and challenged to verify that the findings are true and maybe the new findings will give birth to a new theory.

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Wrap It Up

Science is the systematic observation of natural phenomena and the process of science is the scientific method. If you ignore the scientific method and its principles, you risk making erroneous conclusions. Quality science is observable, measurable and repeatable even when using models. As wonderful as science is, it cannot be the answer to everything. Science has definite limits and a good scientist will recognize these limitations and respect them.

Stop and Think About It

- What is science?
- How is the integrity of science maintained?
- What is the process of science?
- How is science biased?
- What are some limitations of science?
- Why should we study science?
- Can you explain the Scientific Method?
- What is the experimental process?
- What is a hypothesis, theory or law?
- What is data?
- What is qualitative data?
- What is quantitative data?

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