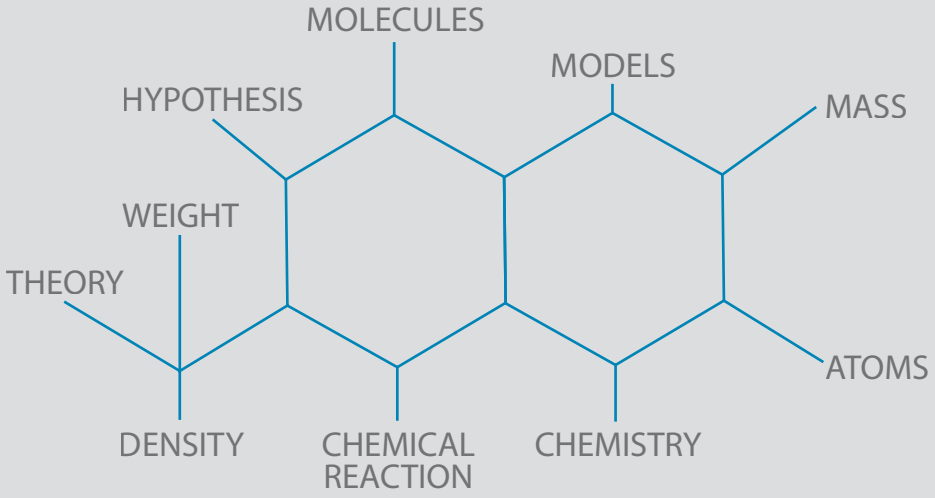
CHAPTER 1

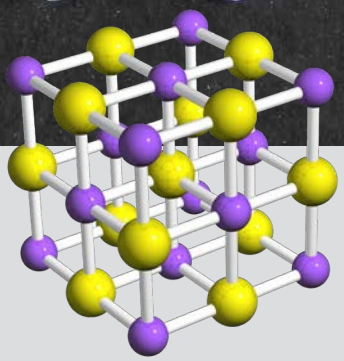
INTRODUCTION

OBJECTIVES AND VOCABULARY

At the conclusion of this lesson the student should have an understanding (as evidenced by successfully completing the quiz at the end of this lesson) of:

1. The concepts of chemistry, scientific models, atoms, and molecules
2. The meanings of the terms mass, weight, density, chemical reactions, hypotheses, and theories
3. The differences between the sources of knowledge of chemistry and the Scriptures.



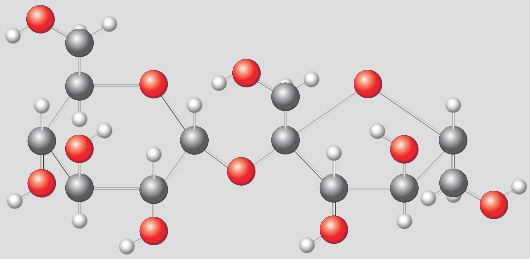


Chemistry is the study of matter, which is the "stuff" that we are made of and everything around us. Matter can be broken down into very small parts that we cannot see called **atoms**. In science, we use **models** to describe what we cannot see but whose effects we can see. Table salt is composed of **molecules,** each of which are composed of one atom of sodium and one atom of chloride. We cannot see these molecules but we can taste them when we have enough of them together in one place. We describe its effects upon the taste buds of our tongues. We describe the sodium chloride molecule (NaCl) with a model of what we call a molecule. We do not know what it really looks like, but we do know its effects.

If something has a foul odor and we cannot see it, we can still smell it. I hope we cannot see it. We know it is there by its odor. The particles of the substance that goes into our noses are too small to be seen, but we still know that they are there. This is especially true when a skunk goes by. When we try to measure these particles, we have to have a lot of them. The units of measurement that we use in chemistry have this idea in mind. We cannot weigh one NaCl (sodium chloride) molecule, but we can weigh a large quantity of them.

The amount of matter in a sample is its **mass** (the mass of all of its atoms added together). The pull of gravity on the mass is its **weight**. Can the weight of an object change without changing its mass? Yes it can. If you go into orbit around the Earth in the International Space Station, your mass remains the same but your weight becomes much less. A helpful application of this concept is that if you know the mass of a sample and the mass of each of the atoms in the sample, you can find out how many atoms are in the sample. We will do this in later lessons.

Early studies of atoms demonstrated that many substances are made up of larger (but still very small) particles called molecules. An example is table sugar (sucrose) that is composed of 12 carbon atoms, 11 oxygen atoms, and 22 hydrogen atoms bonded together. When they come apart and are put back together in a different combination, a **chemical reaction** has occurred.



A structural formula of the chemical compound sucrose (table sugar).

We describe the size of an object by its volume, which is the amount of space it occupies.

Have you ever woken up in the middle of the night wondering why ice floats? If it did not, fish in northern lakes would die in the winter when the water froze from the bottom up. But unlike almost all other molecules, God created water molecules so that they would move farther apart from each other as water freezes into a crystal that we call ice. When the water molecules move farther apart from each other as water freezes, there are fewer water molecules in the same volume. This means that a cubic inch of ice has fewer water molecules than a cubic inch of liquid water. Therefore, a cubic inch of ice has less mass (and weight) than a cubic inch of liquid water. The mass of matter divided by its volume is its **density**. In this situation, ice has a lower density than liquid water.

Try this experiment. Take two equal volumes of water (½ cup) and dissolve about ½ of a teaspoon of table salt in one of them. Place them both in the freezer and see which one freezes first. Try to explain what happened by thinking about what happens when the salt molecules get in between the water molecules as they are trying to form ice crystals.

Your suggested explanation is called a **hypothesis**. Science is based upon making observations and proposing hypotheses. If a hypothesis is supported by many other observations and experiments, it becomes a **theory**. This is very different from a fact because a hypothesis or theory will be later replaced when someone comes up with a better hypothesis that does a better job of explaining the observations. Facts and truth do not change. A hypothesis and theory are temporary because they are stages in our learning process. This is the difference between science and Scriptures of the Christian Bible. The Bible was given to us by God sharing His wisdom with us. Science is a gift that God gave us to better understand the world that He made. Science is good because it gives us many blessings if it is not used for evil purposes.

Facts and truth do not change. A hypothesis and theory are temporary because they are stages in our learning process.

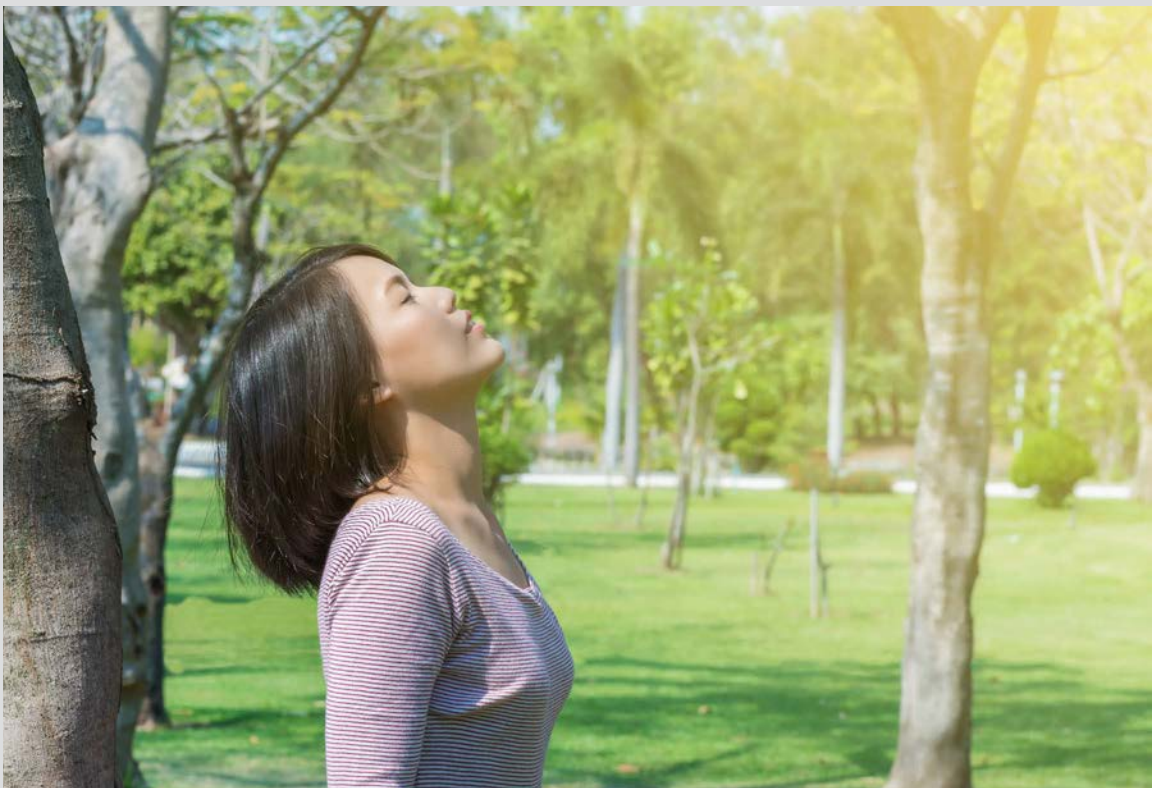
The process of observation, hypothesis, testing the hypothesis and theory is called the scientific method. In some ways, this is what we do all the time. If you got up one morning and found a horse in your kitchen, you would start asking some questions. Why is the horse there and where did it come from and did it eat my breakfast? These are your observations. When you came up with possible explanations, they would be your hypotheses. Then your neighbor from down the street comes up and asks if you saw his horse who snuck off. Now you have information to test your hypotheses. In the scientific community, when a hypothesis is proposed it is published in a scientific journal and read by many interested in that topic. Many will test your hypothesis and if it stands up well with their further testing, it becomes recognized as a theory. Later, someone proposes a better hypothesis and everyone proclaims it to be the theory that replaces yours. Here today, gone tomorrow. Science is good but it is a growth process. Just consider how computers have changed in the last ten years. It is humans trying to understand the physical world.

In science, it is usually emphasized that the observations and experiments be reproducible. A criticism sometimes made against the idea of creation is that you cannot reproduce it and take a closer look at it. But that is also the case in forensics (the study of a crime scene) and the discussions of the evolution of life. It is, however, in science more reliable if you can reproduce the procedures and get the same results.

It is emphasized in science, as well, that your conclusions be falsifiable. For example, you cannot show a hypothesis to be true, because you cannot think of every possible hypothesis to test. Sometime later someone will come up another hypothesis that fits the data much better and replaces all earlier hypotheses. But you can show a hypothesis to be false. A number of years ago a group in Utah claimed to have developed cold fusion. That means that they claimed to be able to fuse the nuclei of two atoms of hydrogen to make a heavier atom with the release of nuclear energy that could be used to heat water into steam to drive an electric turbine. Theoretically and practically the procedure takes a lot of heat energy to slam the atoms together. That is the basis for a hydrogen bomb. When asked to duplicate their results they could not do it. It was determined that their hypothesis was false. Some state that creation cannot be included as an alternative to evolution because it is not reproducible nor falsifiable. That is true. Just like evolution, creation is neither reproducible nor falsifiable. But to reject creation on that basis is to reject God Himself, and the natural world He created. We study God through the Scriptures that He gave us to come to understand Him.

We do not use chemistry to study God but we can see evidence of God in chemistry.

We do not use chemistry to study God but we can see evidence of God in chemistry. Just the mathematical relationships in chemistry attest to the intricate design in creation. As well, the consistency of the structures of the elements and their properties testify of His superior intelligence. Oxygen behaves like oxygen no matter where it comes from. These Laws of Nature are the foundation that has to be there before we can proceed any further in our study. This is something we should not take for granted.



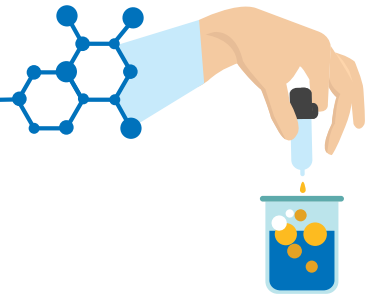
In Scripture, God is not testing and refining His thoughts. He had full knowledge and understanding before the beginning of creation. Our understanding of Scripture improves as we mature and grow closer to Christ but the Scripture itself never has to mature or change. Many stumble when they confuse the authority of science with that of Scripture. Some say that science is something that we can see and test and Scripture is not, so they place their faith in sight rather than God. Our study of science is good but our level of knowledge and understanding is much less than God's. As well, with science we can only study the physical reality. God was before there was a physical reality and life. We have to seek spiritual answers for the origin of physical reality. Before matter was created, there was God, so we have to go to Him and He instructs us through the Scriptures for us to understand the origin of the physical universe. God designed and created matter so when you struggle to understand chemistry, ask Him to come along side of you and be your guide and super Tutor. Wow!

It is also important to distinguish between observation and measurements and hypotheses and theories.

It is also important to distinguish between observation and measurements and hypotheses and theories. I can measure the length of a table or the mass of a sample of NaCl. But if I talk about the structure of the NaCl molecule, I am dealing with a hypothesis about something that I cannot see. Observations and measurements are more like facts, while hypotheses and theories expound on them and provide explanations for the behavior that was observed. Hypotheses can be thought of as tentative explanations, and theories are explanations based on multiple sources with strong evidence. Interesting that some will reject the God that they cannot see but accept the description and reality of a NaCl molecule that they also cannot see.

God created everything we can see and the invisible structures within them that we cannot see. And we are still only beginning to understand how intricate, amazing, and purposeful the Creator's designs truly are!

LABORATORY 1



SCIENTIFIC MODELS

REQUIRED MATERIALS

- Small Box
- Random item that fits in the box

INTRODUCTION

A scientific model is a description of the behavior of something that you have no means of ever seeing with current technologies. You cannot see an atom but you can see the effects of many atoms. You cannot see a proton and you cannot see an electron. But there is something there that is identified by these names. This is a difficult concept because it is contrary to our everyday way of thinking. Can you imagine getting into and riding in an invisible car? Kind of silly, isn't it? But that is what we do with many things in science. We have a model that is a description of something that would behave just like something that we cannot see. The model of an atom is not an actual description of what an atom looks like. It cannot be because we do not know what an atom looks like. The description is the description of something that would behave just like an atom. From this model, we can predict what an atom would do under other circumstances. Our goal is not to describe what an atom actually looks like but rather what it will do.

TEACHER NOTE

This lab requires that you prepare a small, sealed box with an object, unknown to the student, inside for them to analyze.

PURPOSE

This lab exercise is designed to demonstrate how scientific models are designed and used to understand things that cannot be directly observed such as atoms and molecules.

PROCEDURE

This lab is an exercise in constructing a scientific model. Perhaps this will give you a better idea of what a model is and its limitations. You have a sealed box. It has an object in it. You can do almost anything to your box except alter, destroy, or open it. You are not at any time to state or guess what you think is in the box. You will not be shown what is in the box. That is the way it is with atoms and their parts. You are to describe as many properties of the object as you can — but never to identify it! For example, tilt the box and determine if the object slides or rolls in the box. How fast does it roll or slide? What if you tilt it the other way? Does it respond differently? As you hold the box, does the object feel heavy?

Remember that your description cannot have anything to do with what you might think is in the box. Describe at least 6 procedures you perform with the box, your observations, and conclusions. Always use complete sentences. You are not just writing this report for yourself. One of the purposes of the laboratory reports is to improve your writing skills. Part of the grade on the report is how well you follow instructions. At the end of the report, summarize the properties that you can identify for the object in the box. Your report will also be graded on how neat and well organized it is. It can be hand written, but it must be clear.

REPORT

Scientific models

Give a unique name to the object in the box even though you do not know what it is.

For each procedure: describe the procedure and state your observations and conclusions.

Summarize the properties of the object in the box. Remember — do not try to identify what is in the box.

How do you think that this is similar to the way atoms and molecules are studied?