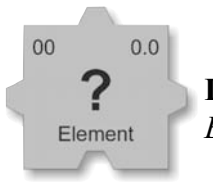
Integrated Physics & Chemistry



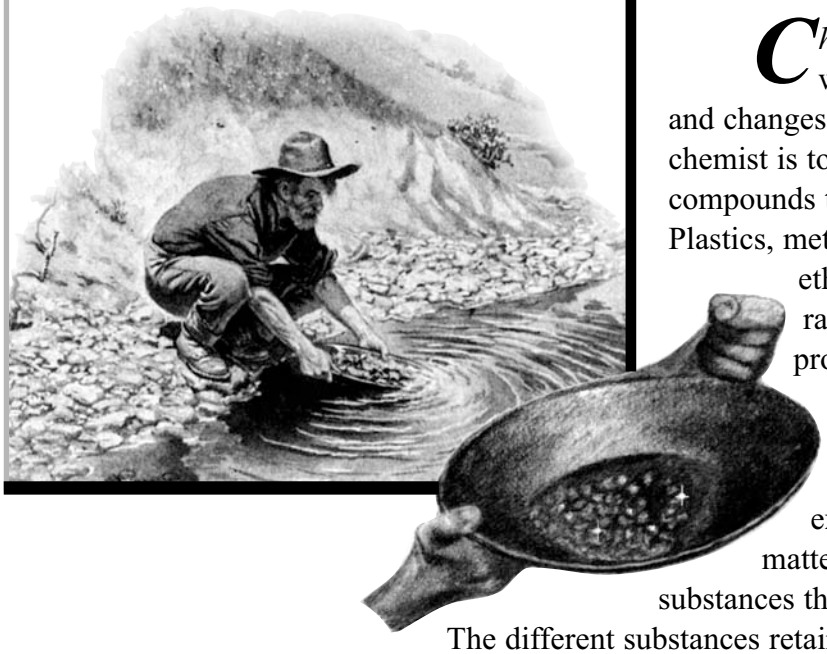
Lesson 2
Elements

Chapter 1

Section 1

Lessons 1-5

CHEMISTS WHO WANTED TO MAKE GOLD



Chemistry is the science that deals with the composition, properties and changes of matter. One activity of a chemist is to combine two or more chemical compounds to produce a new substance. Plastics, metal alloys, some fuels such as ethanol, and many fabrics such as rayon, are new substances produced by the clever application of chemical combinations.

Sometimes, a chemical substance is merely a mixture of existing chemicals. A *mixture* is matter made of two or more substances that are not combined chemically. The different substances retain their own chemical properties. They can be separated by mechanical means; shaking, sorting, filtering or sifting.

A gold prospector pans for gold by swirling a pan of water containing sand, gravel and gold flakes. Each of these is an independent substance and not in chemical combination with one another. Because gold is heavier than the other materials in the pan, a skilled prospector can swirl the water so that the sand, grit and gravel fly out of the pan. Tiny flakes of gold are left behind. The prospector then places the gold flakes in a small jar or leather pouch.

This combination of water, sand, gravel and gold is a mixture. Usually the mixture is not uniform. As the gold prospector moves down the creek bed, the amount of gold and sand changes. Some places contain much gold; other places contain less gold. Gold and other items in the pan make a heterogeneous mixture. ***Hetero-*** means *different*.

VOCABULARY

Hetero-: a prefix meaning "different"
Element: a substance made of the same type of atoms
Atoms: the basic building blocks of matter
Inert: does not readily react with other chemical elements or compounds

The atmosphere is another example of a mixture. The atmosphere contains oxygen, nitrogen, carbon dioxide, water vapor, trace amounts of other gases and suspended particles, such as sulfur and ash. The composition of the atmosphere changes from one location to another. If you take a sample of air from high on a mountain, such as a peak on the island of Maui, Hawaii, compare that sample with one taken along a busy highway in a large industrial city, the composition will not be the same. Even at the same location, a sample of air taken on one day will probably be different from a sample taken on another day.

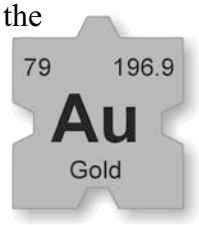
element mixture compound

A *compound* is made of two or more different ***elements*** chemically combined in definite proportions by weight. Pure water is a compound. It has oxygen and hydrogen atoms in the proportion of one oxygen atom for two hydrogen atoms. The elements that make up compounds are always found in exact proportions. For instance, salt has one chlorine atom for each sodium atom. Carbon dioxide has two oxygen atoms for each carbon atom. A diamond is a form of the element carbon.

A mixture of certain elements produces vastly different compound properties. For instance, hydrogen burns explosively in air while oxygen displays a chemical change. Both are gases. Oxygen and hydrogen combined make water, a substance essential for life. A more extreme example is salt, a compound of chlorine and sodium. Chlorine is a heavy green gas while sodium is a soft, silver-white metal that reacts violently with water. Both are poisonous. The compound of these two elements is salt: the harmless, even beneficial, white crystal.

Think about gold. It is neither a compound nor a mixture but is an element. Gold is made of atoms of only one type, gold atoms. ***Atoms*** are the basic building blocks of matter. An element is a substance made of atoms that are all of the same kind. The concept of atoms and elements is an important one in chemistry. The puzzle pieces you will be assembling consist of elements. These elements will be explored in detail throughout the course. The first piece of the puzzle we will discover is the element, gold.

Gold is one of the oldest metals known. Egyptian inscriptions dating back to 2600 B.C. describe gold. In the Old Testament of the Bible, gold is the first metal mentioned. Genesis 2:11 states that gold can be found in the land of Havilah. Ancient people prized gold above all other metals.



Gold has a beautiful yellow color and shines with metallic luster. Gold was probably the first metal discovered. Early people collected gold as jewelry. As time passed, gold was used for money, decoration, fillings in teeth and for plating surfaces. Many space vehicles are wrapped in gold foil because it reflects infrared heat rays. The foil also protects delicate electronic

equipment from the Sun's rays, which otherwise would overheat the instruments.

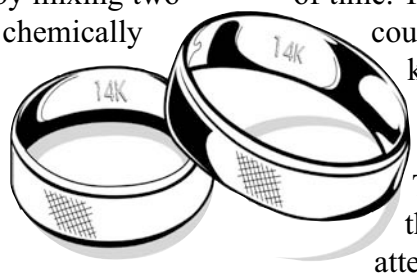
The atmosphere contains oxygen and sulfur. Many metals rust when reacting with oxygen and tarnish when they react with sulfur. Gold is an exception, however, and is relatively ***inert***, which means it is without power to move or to resist. Jewelry and statues of gold will retain their golden glow for centuries without tarnishing.

Gold is also *malleable*. It can be beaten flat into very thin sheets. One ounce (28 grams) of gold is about the size of two quarters stacked together. A sample that size can be flattened into a sheet with an area of 300 square feet. That is enough gold foil to cover the ceiling of an average size living room.

A small nugget of gold beaten flat by a goldsmith can cover large statues or other ornaments. Today, gold foil (flattened gold) is sometimes used for embossing letters on doors of offices, for names on Bibles and for special inlays in paintings. Gold foil is attractive and does not tarnish or fade. Gold foil is so thin it is not very expensive.

One disadvantage of gold is its softness. When used for jewelry or for coins, gold can wear away with use. Mixing it with another metal gives gold greater strength and durability. Gold is most often mixed with copper. The term *carat* describes the amount of gold present. Pure gold is 24 carats. If 14 parts of gold by weight are mixed with 10 parts of copper by weight, the result is 14 carat gold.

Gold cannot be made by mixing two cheaper metals together or by chemically uniting two other compounds. Egyptian chemists and scientists who followed the Egyptians became obsessed with creating gold through secret formulas.



The Egyptians were the most successful chemists of ancient times. They learned to make glass, glaze pottery, extract metals from raw ore, bake, ferment wine, dye cloth, produce perfumes and embalm bodies. Egyptians were unable, however, to produce gold.

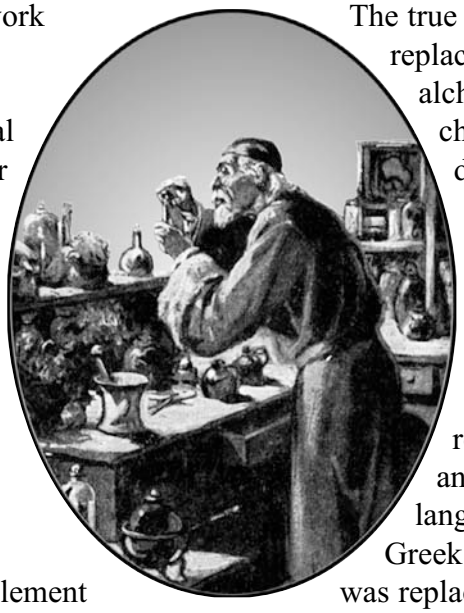
The next great civilization in the chronology of world history after the Egyptians was the Greeks. By observation and reasoning, the Greeks arrived at the idea that everything was made of four elements. The four elements identified by the Greeks were earth, water, air and fire. This was one of the first attempts to identify and name the pieces of the puzzle of the elements. The Greeks claimed all substances could be made by combining the four elements in one proportion or another.

The Greek theory of four elements led chemists to believe they might be able to make gold. Because lead is a heavy metal, and sulfur is a yellow nonmetal, Greeks thought the two items could be mixed in some way to produce gold.

Romans also took the whole idea of making gold very seriously. One Roman emperor was so alarmed with the idea that he ordered all chemistry books destroyed. Romans passed laws proclaiming production of gold as a crime.

From 600 A.D. to 1400 A.D., Europe fell into the Dark Ages (also called the Middle Ages). Science did not advance during this era of time. The Bible was forbidden in many countries, thus, learning and knowledge came to a standstill in Europe. Chemists in the Arab world were known as *alchemists*. Their study of chemistry during the Dark Ages was devoted to attempts to make gold.

Alchemists did their work secretly. They guarded their discoveries by writing secret codes and speaking in mystical languages. They revealed their methods only to trusted assistants. The alchemists worked under the motto, "Never reveal clearly to anyone any discovery."



Neither the Egyptians nor the Greeks discovered how to make gold. The Arabs and the medieval alchemists could not make gold. Their understanding of a chemical element was faulty and hindered chemistry because of their policy of secrecy.

Consequently, chemical discoveries were made time and again only to be lost when an alchemist died. The amount of chemical discovery to survive from the time of Aristotle to the 1600s – almost 2,000 years – was very slight. The period was truly the Dark Ages of academic advancement.

The true science of chemistry replaced the false science of alchemy in the 1600s when church reformers began to demand that common people should be able to read the Bible and write about its application to everyday life and science. The study and publication of chemistry developed because church reformers provided the Bible and other books in the common language of the people; thus, the Greek idea of just four elements was replaced with a more accurate understanding of chemical elements.

The next lesson is about an Englishman who became known as the Father of Modern Chemistry.

Life Principle

"All who have thought about the art of governing are convinced that the fate of empires depends on the education of youth."

—Aristotle