

STATION 5

REPORT YOUR OBSERVATIONS ON SEVERAL EXAMPLES OF ELEMENTS, COMPOUNDS AND MIXTURES.

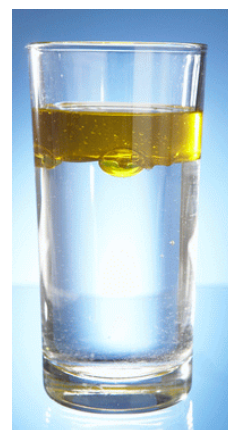
- 1. What are the differences between compounds and mixtures?**
- 2. Do binary (2 elements) compounds have properties that can be predicted from the properties of their elements?**
- 3. Only a few elements display the property of ferromagnetism (strongly attracted to a magnet and capable of holding a magnetic alignment). Test the attraction of the iron filings. This property will be explored further in Station 11.**
- 4. What color is water? By far, what are the most common colors of solids and liquids?**



element - carbon (diamond)



compound - sodium chloride (NaCl)



heterogeneous mixture - oil and water

Concepts - SUBSTANCES: ELEMENTS AND COMPOUNDS.

Terminology - For almost any field, communication is optimized when there is an understanding of the terminology that has developed and evolved for the field. Chemistry is no exception and the words and concepts below are key to communicating in the chemical sciences.

Substance. The lay definition of substance is probably “stuff” but in chemistry substance has a much more specific meaning. A substance is a single chemical and can either be an element or a compound.

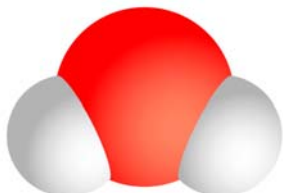
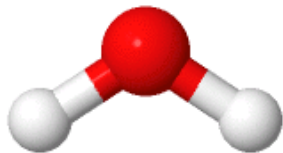
Element. An element is a substance that cannot be broken down into simpler substances by chemical means. Currently, 118 elements have been discovered or synthesized. Elements are composed of atoms which are in turn are composed of protons, neutrons and electrons. The atomic number of an element is the number of protons in the atom (for a neutral atom, there are an equal number of electrons). All atoms of an element have the same number of protons. The number of neutrons in an element is slightly variable and very roughly is the same as the number of protons for the first 20 elements and then increases to a ratio of about 1.6 for the heaviest elements.



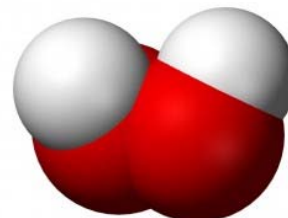
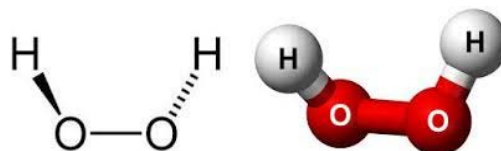
Isotopes are nuclei with same number of protons (one element) but different number of neutrons. While isotopes have very similar chemical properties, some ratios of protons to neutrons are stable and other ratios lead to unstable or radioactive nuclei. The atomic mass is the average mass of the isotopes of the elements as found on the earth. Station 18 will expand on nuclear properties such as nuclear stability and radioactivity.

When two or more elements are combined chemically, a **compound** results. The simplest unit of some compounds is a molecule. It is very important to note that the ratio of the elements in a particular compound is fixed. H_2O or water is a different compound than H_2O_2 (hydrogen peroxide) and has different properties than H_2O_2 . While the formula of a compound can usually be determined based on the elements that compose it, the properties of the compound cannot be predicted from the elements that compose it.

Water (H_2O)

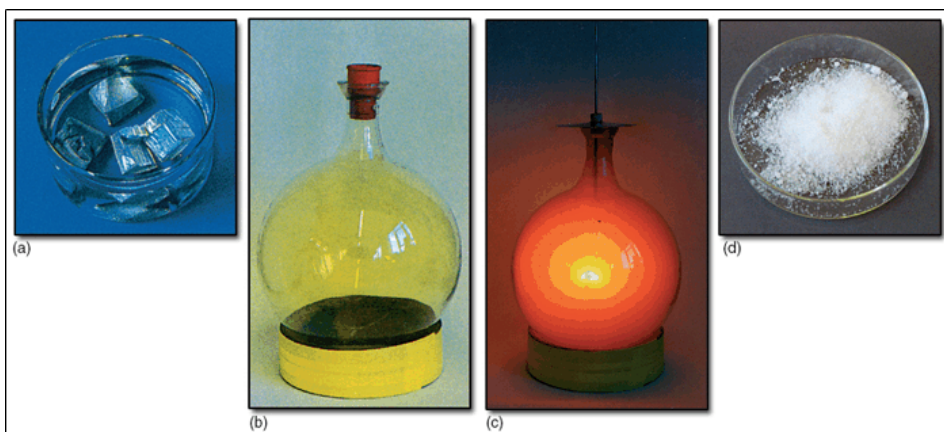


Hydrogen peroxide (H_2O_2)



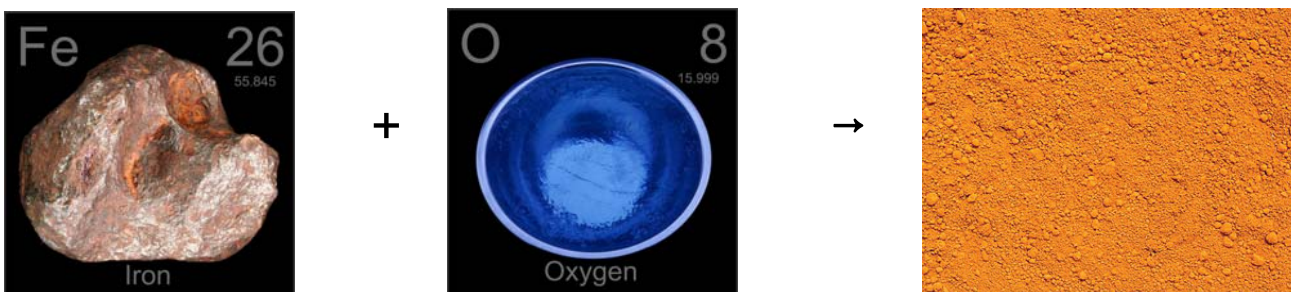
Sodium chloride does not have the properties of sodium or chlorine.

	m.p. (°C)	b.p. (°C)	elect. cond.	den. (g/cm ³)
Na	98	883	yes	0.97
Cl ₂	-101	-35	no	
Fe	1535	2750	yes	7.87
O ₂	-218	-183	no	
S	-113	445	yes	2.07
NaCl	801	1413	no	2.16
Fe ₂ O ₃	1555		no	5.26
FeS ₂	1800			5.0



Sodium (Na) and chlorine (Cl) react to form sodium chloride (NaCl).

Iron (Fe) reacts with oxygen (O₂) to produce iron(III) oxide (Fe₂O₃ - rust) but iron oxide does not have properties similar to iron or oxygen.

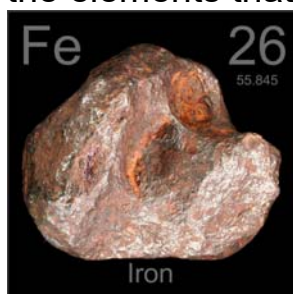


Iron (Fe)

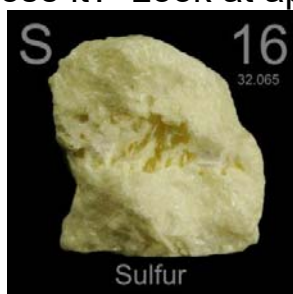
Oxygen (O₂)

Iron(III) oxide (Fe₂O₃ - rust)

Examine the samples of iron, sulfur and iron pyrite (FeS₂). Does the compound resemble the elements that compose it? Look at appearance and test for magnetic properties.



Iron (Fe)

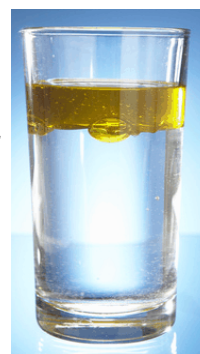


Sulfur (S)



Iron pyrite (FeS₂)
Fool's Gold

A **mixture** results when 2 or more substances are physically mixed. Mixtures differ from compounds in significant ways. While a compound has a definite ratio of elements, mixtures have variable composition. Compounds cannot be separated into simpler substances by physical means but mixtures can be separated using physical separation techniques such as filtration, crystallization, distillation and chromatography.



oil and water



sand and water

Station 5 - Answers to questions.

- Compounds are composed of two or more elements in a definite and fixed ratio. While the elements can potentially be separated using chemical means, the elements cannot be separated using physical changes. Mixtures are composed of two or more substances. The composition is variable and the substances can be separated using physical techniques.
- As demonstrated above, the properties of compounds cannot be predicted from the properties of the elements that compose the compound. Compounds are totally distinct from their elements.
- There are two general types of magnetism. Diamagnetic substances are very, very weakly repelled by magnetic fields. Paramagnetic substances are weakly attracted to magnets unless they fall into the somewhat rare subcategory of ferromagnetism. Ferromagnetic substances are strongly attracted to magnetic fields. While it is difficult to predict ferromagnetic properties, paramagnetic substances have unpaired electrons and diamagnetic substances have only paired electrons. Ferromagnetic substances differ from regular paramagnetic substances by having the ability to hold magnetic alignments.
- Communication is an extremely important skill and yet most people incorrectly say that the color of water is clear. Clear is not a color and the best answer is "colorless." Despite the erroneous images with a myriad of colored chemicals presented in chemistry labs in movies and on TV, most solids are white and most liquids are colorless. This presents a problem when food scientists are looking for food colorings. Most colored inorganic substances are toxic and colored organic compounds tend to be carcinogenic thus the viable choices for food colorings are extremely limited.

Comparison of Dia, Para and Ferro Magnetic materials:

DIA	PARA	FERRO
<p>1. Diamagnetic substances are those substances which are feebly repelled by a magnet. Eg. Antimony, Bismuth, Copper, Gold, Silver, Quartz, Mercury, Alcohol, water, Hydrogen, Air, Argon, etc.</p>	<p>Paramagnetic substances are those substances which are feebly attracted by a magnet. Eg. Aluminium, Chromium, Alkali and Alkaline earth metals, Platinum, Oxygen, etc.</p>	<p>Ferromagnetic substances are those substances which are strongly attracted by a magnet. Eg. Iron, Cobalt, Nickel, Gadolinium, Dysprosium, etc.</p>
<p>2. When placed in magnetic field, the lines of force tend to avoid the substance.</p>	<p>The lines of force prefer to pass through the substance rather than air.</p>	<p>The lines of force tend to crowd into the specimen.</p>
