Elements & Compounds

Holt Chapter 4, Lecture 1

It's all elemental!

- An element is about as simple as it gets.
- It cannot be broken down into anything else.
- We know a substance is an element if we keep making it smaller and smaller, but each piece is still made up of **one** type of atom.
- An element is a **pure** substance, or a substance that has only one type of particle or atom.

Gold = Element

- For example, gold (Au), is a pure substance, an element.
- If you take a nugget of gold and keep breaking it down, each particle (atom) looks exactly the same.
- It is made up of ONLY gold atoms.

Names of Elements

- Each element has a special name and some are very ancient.
- The element copper is derived from Cyprus, where it was once mined.
- Vanadium, which forms beautiful compounds, is named after the Scandinavian goddess Vanadis.
- The International Union of Pure and Applied Chemistry (IUPAC) decides on the element names.

Element Symbols

- An element also has a **chemical symbol**, made up of either one or two letters.
- If the symbol has two letters, the first is capitalized and the second is **lower** case
- Many of the symbols are the first letter or two of the element: hydrogen (H), oxygen (O), nickel (Ni), helium (He)
- Other symbols are of the first letter and the 3rd letter: chlorine (Cl).
- Others are derived from the Latin, Greek or German name: iron (Fe).

Guessing Game: Can you guess the right symbol for each element?

1. Lithium
   - Li
2. Beryllium
   - Be
3. Boron
   - B
4. Nitrogen
   - N
5. Sodium
   - Na
6. Chromium
   - Cr
7. Uranium
   - U
8. Californium
   - Cf
9. Plutonium
   - Pu
10. Mercury
    - Hg

Element Properties

- Every element is unique, with its own special properties that make it different from every other element.
- We call these **characteristic** properties.
- Of course, some elements are pretty similar to one another, but there's always something that makes it different from the rest.
- These small differences, both physical & chemical, separate the elements into 3 main categories.

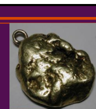
Element Categories

There are only 3 categories for elements:

1. **Metals**
2. **Nonmetals**
3. **Metalloids**

Each element falls into one of these categories and shares common properties, though keep in mind - there are always exceptions.

Metals



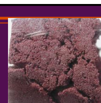
- **Good** conductors of electricity and heat
- **Shiny** (metallic luster)
- **Malleable** (hammered into sheets)
- **Ductile** (drawn into thin wires)

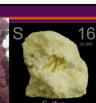
Example: Aluminum (Al)

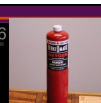
Think of aluminum foil, it is a classic metal. Why?

(1) it's shiny
(2) It's malleable - flattened into very thin sheets
(3) it conducts electricity

Nonmetals



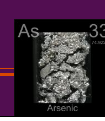




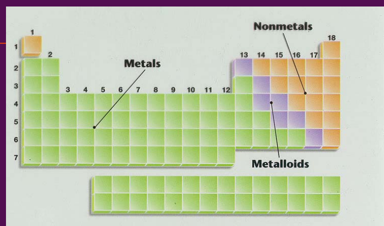
- **Poor** conductors of electricity and heat
- **Dull** (not shiny)
- **Brittle** - not malleable
- **Not** ductile
- Examples: gases (Hydrogen, Helium, Oxygen, etc.) & odd non-gases (Sulfur, Carbon, Phosphorous).

Metalloids or semiconductors

- Possess properties of both metals and nonmetals - some metalloids are ductile but not shiny, etc.
- Usually, they look like a **metal**, but behave *chemically* like a **nonmetal**.
- The **7** metalloids are: Boron, Silicon, Germanium, Arsenic, Antimony, Tellurium, Polonium.



Periodic Table of Elements



- In our next unit we' ll learn about how elements are organized in the Periodic Table.
- Is it coincidence that metals are on the left side of the table and nonmetals on the right, with metalloids running diagonally between them?

Compounds

- While some elements are found in their pure form in nature, most are bonded to other elements.
- A compound is a **pure** substance made up of two or more elements that are **chemically combined.**
- In order to combine two elements to make a compound, the elements have to *chemically react* with one another.
- The elements in a compound are not simply mixed together, they are actually joined or **bonded** to one another in a specific way.
- Complicated? Basically, ***a compound is one or more elements stuck together***!

Definite Ratios

- What' s more, a compound is made up of a **DEFINITE ratio** of these elements.
- Salt (sodium chloride) is made up of 1 sodium atom and 1 chloride atom.
- The ratio is always 1:1 (1 to 1, or 1/1). It doesn' t matter if you were looking at salt in California, Siberia, or Mars - it' s always the same.
- Similarly, in water, there are always 2 hydrogen atoms to 1 oxygen atom.
- In fact, we call this the **law of constant composition.**

Classified Compounds

We really have only two types of compounds:

1. **Organic compounds** are compounds that contain carbon and usually hydrogen. They are called organic because it was ONCE believed that they could only be formed by living organisms.
2. **Inorganic compounds** are all other compounds.

Compound Properties

- Just like elements, each compound has unique properties that help identify and distinguish the compound.
- Usually, a compound' s properties are **VERY different** from its constituent elements.
- For example, look at salt, sodium chloride.
  - Sodium: reacts violently with water
  - Chlorine: a poisonous deadly gas
  - However, when we put the two together - we get salt, which is definitely safe to eat and dissolves in water.

Interesting Tidbit

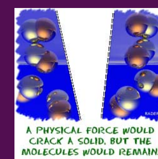
In ancient times, salt was a precious commodity. It was even traded for an equal weight of gold. Soldiers in ancient Rome, as part of their pay, often received a *salarium*, a special ration of salt (Salt in latin is *sal*). This term eventually evolved into the English word salary, a payment for work.

Breakin' it down

- ~~Since compounds are made up of several elements,~~ it makes sense that we can separate the elements.
- In other words, a compound can be broken down into similar elements through chemical change (heat, reactions).
- For example, carbonic acid is a gas that gives soda its carbonation or fizz. This compound can be broken down into simpler carbon dioxide and water.
- What happens when you open up a soda and leave it out? The released pressure lets the carbonic acid separate into its simpler elements - and goes flat.

IT'S NOT PHYSICAL

- The only way to break down a compound is through CHEMICAL change, not physical change.
- Think about it - compounds are made up of elements that are BONDED to one another. The only way to rip apart the bonds is by providing some serious energy to the whole thing.
- **Heating** is one way to separate compounds.
- **Electrolysis** is another method, where an electric current is used to break down the compounds.



Review:

- 1. What do you know about elements?
  - **Pure** substances
  - **Cannot** be broken down
  - Each element has unique properties
  - Classified into metals, nonmetals, metalloids.
  - Examples: Argon gas, Nitrogen gas

Review

- 2. What do you know about compounds?
  - Pure substances
  - Made of 2 or more elements
  - Each compound has unique properties that may differ from its individual elements
  - Always form in definite ratios
  - CAN be broken down into simple substances
  - Example: water (H_2O, NaCl, CO_2)

Review

3. What are the 3 categories of major elements?

Metals, nonmetals, metalloids

4. Describe the differences between metals, nonmetals, & metalloids:

Metals: good conductors, shiny, malleable, ductile

Nonmetals: opposites of metals

Metalloids: act like both of them

Review

5. How are elements and compounds alike? And different?

Both are pure substances, but elements cannot be broken down into anything simpler while compounds can be broken down into elements

6. What are 2 ways to break down a compound?

Heating and electrolysis

Mixtures & Solutions

Mixtures & Compounds

Pizza Pizza

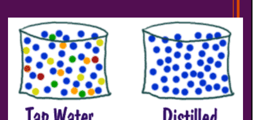
- What does it take to make the perfect pizza?
- A perfectly round and rolled out pizza dough, covered with an even layer of mouth-watering red sauce, buried beneath freshly grated mozzarella, and topped with your favorite toppings (pineapple!)
- What does this make? A mixture!!!

It's called a Mixture

- A pizza is a perfect example of a **mixture**.
- A **mixture** is a **combination** of two or more substances - that are **NOT chemically** combined.
- If they react and combine chemically, it will become a **compound** instead.
- The ingredients in a pizza are all mixed together, but you still have separate ingredients.
- The cheese and sauce haven't combined to make a brand new substance.

Example of a Mixture: Water

- When you see distilled water, it's a **pure substance.**
- That fact means that there are just water molecules in the liquid.
- Your tap water is a **mixture** of water with other things dissolved inside, maybe salt.



More, more, & more mixtures!

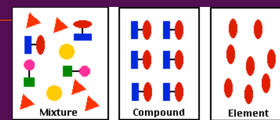
- Air consists of nitrogen, oxygen and other small amounts of various gases.

- Seawater is a mixture of water with dissolved chemicals such as sodium chloride.
- Gasoline is a mixture of hydrocarbons and other additives.
- People are highly complex mixtures made of mostly organic compounds.
- Medicine, perfume, the list goes on and on.

Don't change me!

- **Mixtures** don't like change & **keep their identity**.
- In other words, because no chemical reactions took place, substances are the same before and after you mix them together.
- Because of this, it is still possible to **physically separate** the substances from one another.
- Remember that with **compounds**, we can only separate them using chemical means (heating and electrolysis).

Yes, I am different & special



- What else makes a **compound** different from a **mixture**?
- In a **mixture**, the components **do not have a definite ratio.**
- In your pizza, you can add as much cheese or as little sauce as your heart desires.

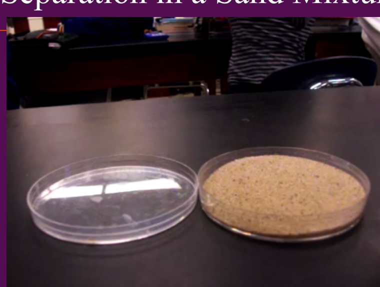
Mixtures Vs. Compounds

- This is where it gets complicated - being able to tell the difference between a **mixture** and a **compound**.
- Think of water, a **compound**, made up of the elements hydrogen and oxygen.
- Not only is water totally different from its elements, but you can't easily separate the elements from the water.

Mixtures Vs. Compounds

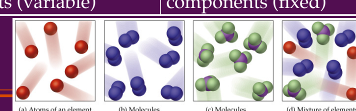
- On the other hand, if you mixed sugar and sand in water, the **mixture** is both sweet (from the sugar) and gritty (from the sand).
- This sugar dissolves, but the sand doesn't - which lets you separate them easily.
- Isn't that genius?

Separation in a Sand Mixture



Mixtures Vs. Compounds

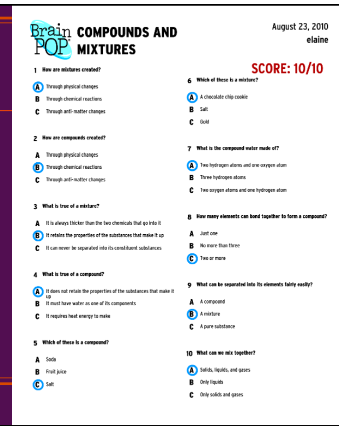
Mixtures	**Compounds**
Made of **elements, compounds, or both**	Made of **elements**
Components **keep** their original properties	Components **lose** their original properties
Separated by **physical** means	Separated by **chemical** means
Formed using **any ratio** of components (variable)	Formed using **a set ratio** of components (fixed)



And now Tim & Moby Compounds & Mixtures

- BrainPOP

Brainpop: Mixtures/ Compounds



BrainPOP COMPOUNDS AND MIXTURES

August 23, 2010
elaine

SCORE: 10/10

1 How are mixtures created?
- (A) Through physical changes
- B Through chemical reactions
- C Through anti-matter changes

2 How are compounds created?
- A Through physical changes
- (B) Through chemical reactions
- C Through anti-matter changes

3 What is true of a mixture?
- A It is always thicker than the two chemicals that go into it
- (B) It retains the properties of the substances that make it up
- C It can never be separated into its constituent substances

4 What is true of a compound?
- (A) It does not retain the properties of the substances that make it up
- B It must have water as one of its components
- C It requires heat energy to make

5 Which of these is a compound?
- A Soda
- B Fruit juice
- (C) Salt

6 Which of these is a mixture?
- (A) A chocolate chip cookie
- B Salt
- C Gold

7 What is the compound water made of?
- (A) Two hydrogen atoms and one oxygen atom
- B Three hydrogen atoms
- C Two oxygen atoms and one hydrogen atom

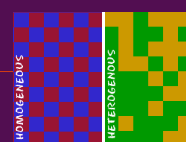
8 How many elements can bond together to form a compound?
- A Just one
- B No more than three
- (C) Two or more

9 What can be separated into its elements fairly easily?
- A A compound
- (B) A mixture
- C A pure substance

10 What can we mix together?
- (A) Solids, liquids, and gases
- B Only liquids
- C Only solids and gases

Part 3: Solubility Heterogeneous Homogenous Mixtures & Solutions

Solutions



- A **solution** is a mixture that appears to be a single substance, but is made of particles of 2 or more substances that are evenly distributed among each other.
- They are also referred to as **homogenous mixtures.**
- In short, a solution is a mixture, where the particles are so well mixed that the composition is the same throughout and we can't see distinct molecules, even with a microscope.

Special Solutions

- Not all solutions are liquids.
- **Alloys** are solid solutions of metals and nonmetals that have dissolved in metals.
- Brass is an example of an alloy - it is zinc dissolved in copper.
- Steel is carbon and other elements dissolved in iron.
- Gases can be solutions too.

Homogeneous Mixtures

- A homogeneous mixture is a uniform mixture where you can't otherwise tell that there are multiple phases.
- If it's gases it's homogeneous
- if it's solids you have to look at it. Steel is a mixture of iron and carbon, but you wouldn't know. A box of copper and steel nuts you can tell apart.

Homogeneous Liquid Mixtures

- ✧If it's a liquid mixture and you can see through it it's homogeneous
- ✧Tea is a homogeneous mixture.
- ✧Milk is not.

Homogeneous & Heterogeneous Mixtures

Heterogeneous Mixtures

- If you can clearly tell that there is more than one thing in a container it' s heterogeneous
- If there is a liquid that you can' t see through it' s heterogeneous
- If you can tell there is an easy way to separate things then it' s a heterogeneous mixture.

Heterogeneous Mixtures

Summary

HOMOGENEOUS

<u>Pure Substances & Solutions</u>

Elements or compounds which CAN'T be physically separated

Looks like <u>a single</u> substance
- Particles are really really small
- Particles are thoroughly & evenly mixed

Examples: Oxygen & Carbon Dioxide

HETEROGENEOUS

<u>Mixtures;</u>

These CAN be physically separated

Can see the different parts
- Particles range in size, but definitely visible
- Types:

Examples: Soil & Sugar Water

Suspensions

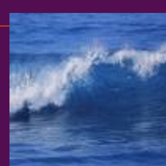
- A **suspension** is a <u>mixture</u> where the particles are mixed in a solvent, but do not dissolve because they are large.
- Think of a snow globe. The snow particles are mixed in with the fluid, but do not dissolve.

Soluble & Insoluble

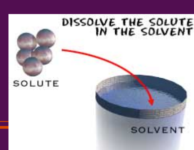
Solutes & Solvents

- **<u>Dissolving</u>** is when substances separate and spread evenly throughout the mixture.
- **<u>Solute</u>** = the dissolved substance.
- **<u>Solvent</u>** = the substance the solute dissolves in
- If something is **<u>soluble</u>**, that means it can dissolve in the solvent.
- If it is **<u>insoluble</u>**, that means it cannot dissolve in the solvent (rocks in water).
- Confused yet?

Example: Salt Water



- Salt is highly soluble in water - that means it dissolves in water.
  - Salt = **<u>the solute</u>**
  - Water = **<u>the solvent</u>**
- In fact, water dissolves so many substances, that it is called the **<u>universal solvent</u>**.



Solvent and Solute

- The chemical that is the majority of the mass and **is <u>dissolving</u>** another compound is the **<u>solvent</u>**.
- The compound making up the smaller share of the mass and is **<u>being dissolved</u>** is the **<u>solute</u>**.

How much are you dissolving?

- **<u>Concentration</u>** is the amount of solute dissolved in the solvent.
- A lot of times, it is in grams per milliliter of solvent, or g/mL
- **<u>Dilute</u>** = less solute
- **<u>Concentrated</u>** = more solute
- If the solute is colored, then a dilute solution is usually pale, whereas a concentrated solution is dark

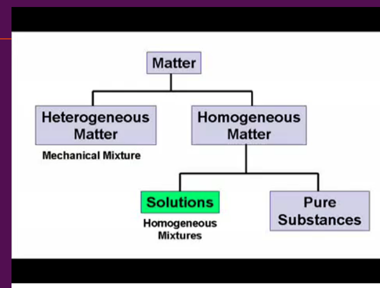
Concentration

Speed it up!

There are 3 methods to make a particle dissolve faster:

- **Mixing** - stirring or shaking causes the particles to separate and spread more quickly
- **Heating** - causes particles to more more quickly and separate
- **Crushing** - increases the amount of contact between the solute and solvent and causes better mixing

Solution Review



And now…we solute you!