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Chemistry &
The Scientific Method

The Foundations of Chemistry

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Why Chemistry?

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The Problem with Chemistry

General Chemistry can seem like a bunch of barely connected concepts about a bunch of strange little things (molecules) that you never directly observe.

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The Context of Chemistry

All of those seemingly unconnected concepts are really a series of questions that could be asked about the reactions and physical properties of molecules.

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EVERYTHING is Chemistry

All substances are constructed of molecules.
Chemistry is the study of those molecules.

This study has 2 main areas of study.

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The Physical of Chemistry

"What are their physical properties?"

1. State of matter (solid, liquid, gas)
2. Boiling point
3. Freezing point
4. Solubility in other liquids
5. Malleability
6. Electrical Conductivity
7. Heat Conduction
8. Tensile Strength

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The Chemical of Chemistry

What is the reactivity of the molecules?

1. Will they react to form new substances with A, B, or C?
2. How fast will that reaction occur?
3. Are the likely products more stable than the reactants?
4. What is the yield of the reaction? What limits the yield of the reactions?
5. Does the reaction create energy or require energy?
6. Does the reaction use electrons or generate electrons?
7. What is the structure of the new materials?
8. Are any byproducts generated by the reaction?

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The Difference?

Chemical properties (& changes) involve changes in COMPOSITION.

Physical properties (& changes) involve a constant composition.

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Chemistry is about Every Thing

Chemistry is the most practical of sciences. Chemistry is rooted in the investigation of materials (real things) and their properties. As a result, other sciences like Biology, must rely on Chemistry for information about the "things" they study.

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Building Blocks of Matter

- ❑ Chemistry is the study of **matter** - which is anything that has mass and takes up space. In other words, Matter is ANY-THING.
- ❑ Matter itself has a wide variety of properties. What these properties are and how these properties can be changed is important to the function of everything from a rock to a human being.

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Divisible vs. Indivisible

The world we see around us appears to be quite divisible - it can be divided into pieces of the whole.

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The Chemical vs. The Physical

- When we talk about the "physical properties" of materials, we are talking about molecules. Molecules are the smallest, indivisible units of matter that maintains the identity (and most properties) of that matter.
- When we talk about the "chemical properties" of materials, we are talking about atoms. Chemistry is often defined as the making or breaking of bonds to rearrange the atoms in a molecule.

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What if you have more than 1 type of molecule?

What's the difference between sugar-water and sugar?

Sugar is dry	Sugar-water is wet
Sugar is sweet	Sugar-water is sweet
Sugar melts if heated	Sugar-water boils

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Both have sugar, but...

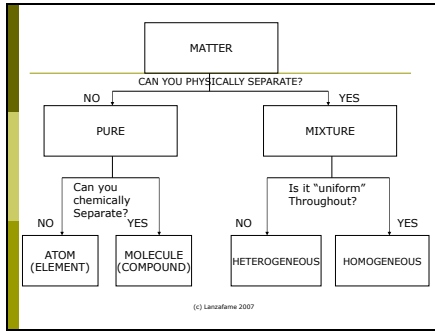
Sugar (glucose) is a single type of molecule.

Sugar-water is a **mixture** of sugar molecules and water molecules.

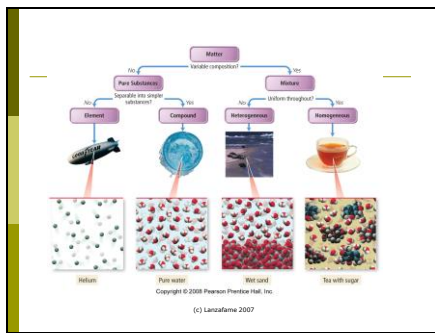
A mixture usually has some properties that are different from either of its substituents. It might also share a few: sugar-water and water are both wet. Sugar-water and sugar are both sweet. But boiling point of sugar-water is different than the boiling point of sugar and the boiling point of water.

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What is it?

Sugar-water
 mixture
 Made up of water and sugar
 Homogenous mixture
 Each part of the pitcher is identical: there is some water and some sugar, it is clear and colorless

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What is it?

Mayonnaise
mixture
Made up of eggs and oil and water and...???
Homogenous mixture
Each part of it is identical: it is white and smooth

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What is it?

Sweet Relish
mixture
Made up of pickles and water and sugar and peppers and corn
Heterogenous mixture
You can see the difference between the pickles and the peppers and between the peppers and the corn.

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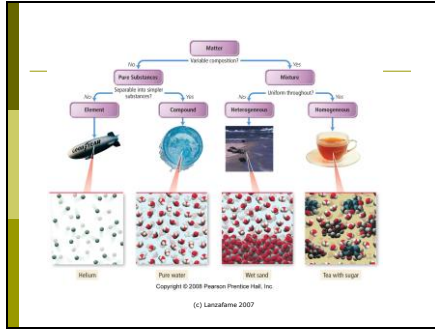
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Questions???

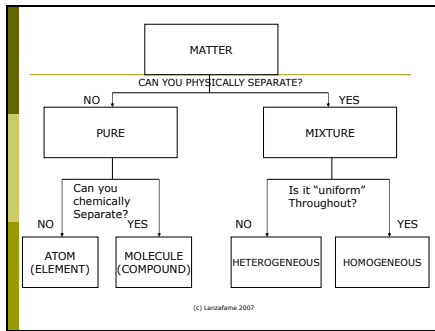
It's all about being able to ask the questions and then finding the answers.

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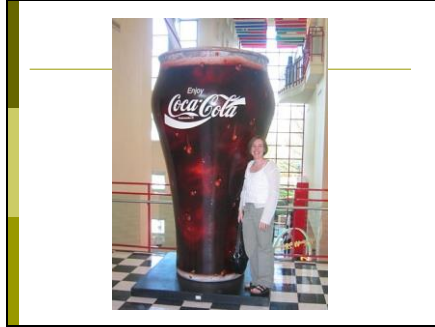
Clicker Question

Consider a glass of Coke with no ice cubes.
 It is...

- A. A pure substance
- B. An element
- C. A homogeneous mixture
- D. A heterogeneous mixture

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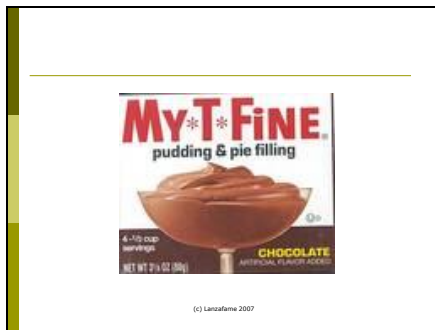
Clicker Question

Consider chocolate pudding:

- A. A pure substance
- B. An element
- C. A homogeneous mixture
- D. A heterogeneous mixture

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Clicker Question

Consider a hamburger:

- A. A pure substance
- B. An element
- C. A homogeneous mixture
- D. A heterogeneous mixture

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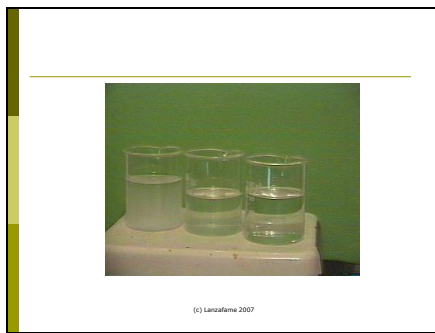
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Summary

Chemistry is about every Thing.

"Things" can be pure substance (elements or compounds) or mixtures (heterogeneous or homogeneous)

Chemistry is concerned with the measurement and understanding of the chemical and physical properties of materials.

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A word about Energy...

Energy is a difficult concept to define. It is often easier to define it in terms of what it does rather than what it is.

Energy, difficult as it is, is a critical concept underlying the physical sciences because energy provides the impetus for changes.

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Energy

Energy is often defined as "the capacity to do work". So, it is usually the work being done that you see.

Work is "the action of a force through a distance".

So, if I push a chair 10 feet across the floor. My force (push) acting over a distance (10 feet) is work. The food I eat and its subsequent metabolism provides "capacity to do work" (energy).

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Energy = kinetic energy + potential energy

Kinetic energy is energy of motion (my moving chair)

Potential energy is stored energy (food - chemical potential energy)

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Turning Potential into Kinetic

Kinetic (horizontal bike)
+ potential (height)

potential (height)
heat (squash)

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At ALL times, the total energy in the system is conserved (remains the same).

Total = kinetic + potential + heat

Heat is actually molecular kinetic energy

If you wanted to change the amount of energy in the system, you'd need to do WORK to add or subtract energy from the system (for example, carry the wrecked bike back up to the roof).

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Chemical Energy

We will, at various times, explore the energy changes involved in molecular interactions (sadly, we don't get to throw things off the building – we leave that to physicists.)

Stored chemical energy is a form of potential energy

Molecular motions are kinetic energy (heat)

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