

Chem 103, Section F0F  
Unit I - An Overview of Chemistry  
Lecture 1

- An introduction to some jargon; learning to speak like a chemist
- Chemistry, from the dark arts to science
- A scientist's approach to understanding nature

Lecture 1 - Introduction

The power of "seeing" and understanding nature at the molecular level

- Example: The neural synapse:



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Lecture 1 - Learning the Jargon

As with any endeavor that involves interactions with others, you need to know the language.

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Lecture 1 - Learning the Jargon

Let us start with **Chemistry**:

**Chemistry** is *the study of matter and its properties, the changes that matter undergoes, and the energy associated with those changes.*

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Lecture 1 - Learning the Jargon

**Matter**

- Any thing that has *mass* and *volume*

**Composition of matter**

- The types and amounts of simpler *substances* that make up a sample of matter.

**Properties**

- The *characteristics* that give each substance its unique identity.

**Physical properties**

- Those that a pure substance shows by itself, without changing into, or interacting with, another substance.

**Chemical properties**

- Those that a pure substance shows as it changes into or interacts with another substance (or substances).

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Lecture 1 - Learning the Jargon

**Physical Change**

- A change that occurs when a substance alters its *physical form*, but not its *composition*

**Chemical Change**

- A change that occurs when a substance (or substances) is converted into a different substance (or substances). This is called called a **chemical reaction**.

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## Lecture 1 - Learning the Jargon

### Physical *versus* Chemical Properties:

Table 1.1 Some Characteristic Properties of Copper

#### Physical Properties

Reddish brown, metallic luster

Easily shaped into sheets (malleable) and wires (ductile)



Good conductor of heat and electricity



Can be melted and mixed with zinc to form brass

Density = 8.95 g/cm<sup>3</sup>  
Melting point = 1083°C  
Boiling point = 2570°C

#### Chemical Properties

Slowly forms a blue-green carbonate in moist air



Reacts with nitric acid (photo) or sulfuric acid



Slowly forms deep-blue solution in aqueous ammonia



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## Lecture 1 - Clicker Question 1

Identify the highlighted property described in the following statement as either *physical* or *chemical*:

**Yellow green chlorine gas attacks silvery sodium metal to form white crystals of sodium chloride (table salt).**

- A) Physical
- B) Chemical

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## Lecture 1 - Clicker Question 2

Identify the highlighted property described in the following statement as either *physical* or *chemical*:

**Yellow green chlorine gas attacks silvery sodium metal to form white crystals of sodium chloride (table salt).**

- A) Physical
- B) Chemical

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## Lecture 1 - Clicker Question 3

Identify the highlighted property described in the following statement as either *physical* or *chemical*:

**Yellow green chlorine gas attacks silvery sodium metal to form white crystals of sodium chloride (table salt).**

- A) Physical
- B) Chemical

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## Lecture 1 - Clicker Question 4

Identify the highlighted property described in the following statement as either *physical* or *chemical*:

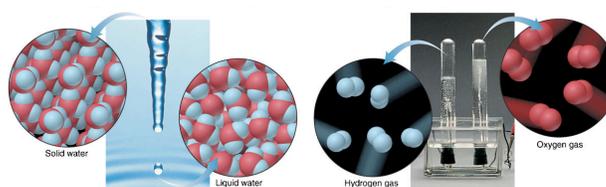
**Yellow green chlorine gas attacks silvery sodium metal to form white crystals of sodium chloride (table salt).**

- A) Physical
- B) Chemical

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## Lecture 1 - Learning the Jargon

### Physical *versus* Chemical change



**A Physical change:**  
Solid form of water becomes liquid form; composition does *not* change because particles are the same.

**B Chemical change:**  
Electric current decomposes water into different substances (hydrogen and oxygen); composition *does* change because particles are different.

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### SAMPLE PROBLEM 1.2 Distinguishing Between Physical and Chemical Change

**PROBLEM** Decide whether each of the following processes is primarily a physical or a chemical change, and explain briefly:

- Frost forms as the temperature drops on a humid winter night.
- A cornstalk grows from a seed that is watered and fertilized.
- A match ignites to form ash and a mixture of gases.
- Perspiration evaporates when you relax after jogging.
- A silver fork tarnishes slowly in air.

**PLAN** The basic question we ask to decide whether a change is chemical or physical is, "Does the substance change composition or just change form?"

**SOLUTION** (a) Frost forming is a physical change: the drop in temperature changes water vapor (gaseous water) in humid air to ice crystals (solid water).

(b) A seed growing involves chemical change: the seed uses water, substances from air, fertilizer, and soil, and energy from sunlight to make complex changes in composition.

(c) The match burning is a chemical change: the combustible substances in the match-head are converted into other substances.

(d) Perspiration evaporating is a physical change: the water in sweat changes its form, from liquid to gas, but not its composition.

(e) Tarnishing is a chemical change: silver changes to silver sulfide by reacting with sulfur-containing substances in the air.

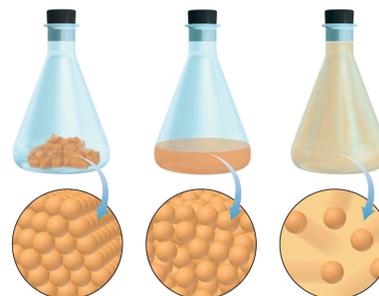
**FOLLOW-UP PROBLEM 1.2** Decide whether each of the following processes is primarily a physical or a chemical change, and explain briefly:

- Purple iodine vapor appears when solid iodine is warmed.
- Gasoline fumes are ignited by a spark in an automobile engine's cylinder.
- A scab forms over an open cut.

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## Lecture 1 - Learning the Jargon

### The three states of matter



**Solid**  
Particles close together and organized

**Liquid**  
Particles close together but disorganized

**Gas**  
Particles far apart and disorganized

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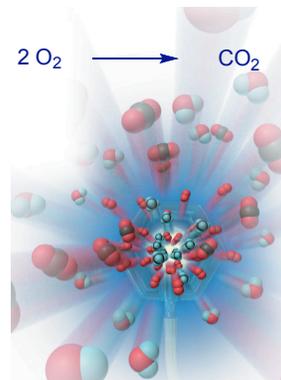
## Lecture 1 - Learning the Jargon

*In chemistry, **macroscopic** properties and behaviors, those we can see, are the results of **submicroscopic** properties and behaviors that we cannot see.*

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## Lecture 1 - Learning the Jargon

### A flame



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## Lecture 1 - Learning the Jargon

### Energy

- The ability to do **work**.

### Potential energy

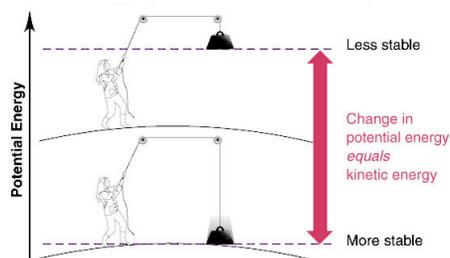
- The energy that an object has due to its position.

### Kinetic energy

- The energy that an object has due to its motion.

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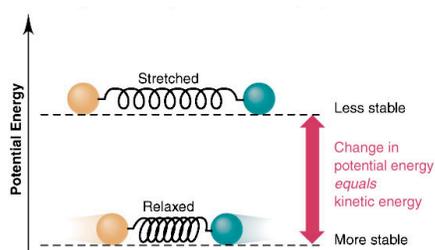
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**A** A gravitational system. The potential energy gained when a weight is lifted is converted to kinetic energy as the weight falls.

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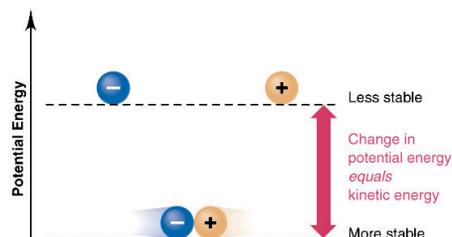
## Lecture 1 - Learning the Jargon



**B** A system of two balls attached by a spring. The potential energy gained when the spring is stretched is converted to the kinetic energy of the moving balls when it is released.

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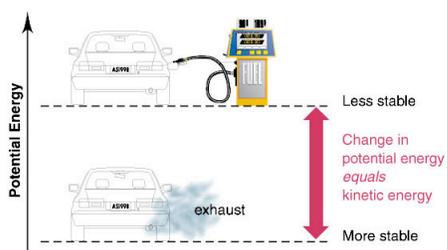
## Lecture 1 - Learning the Jargon



**C** A system of oppositely charged particles. The potential energy gained when the charges are separated is converted to kinetic energy as the attraction pulls them together.

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## Lecture 1 - Learning the Jargon



**D** A system of fuel and exhaust. A fuel is higher in chemical potential energy than the exhaust. As the fuel burns, some of its potential energy is converted to the kinetic energy of the moving car.

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## Lecture 1 - From the Dark Arts to Science

### Alchemy

- 1<sup>st</sup> century A.D. to 1500 A.D.
- Matter naturally strives toward perfection
  - Turning baser metals into Gold (The Midas touch)
- Folk remedies
- These efforts lead to the discovery of techniques for separating substances



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## Lecture 1 - From the Dark Arts to Science

### Lavoisier and Phlogiston Theory (1743-1794)

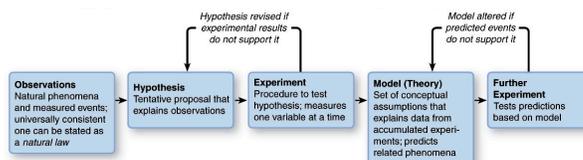
- Phlogiston theory
- Issues with phlogiston theory
  - Why is air needed?
  - Why do metals gain mass when burned to form *calx*.
- Lavoisier, through careful measurements, could account for the increase in mass.
  - Due to combination of the metal with oxygen (*combustion*).



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## Lecture 1 - The Scientific Approach

Lavoisier's approach to studying natural phenomenon is now embodied in what we call "the scientific approach".



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## Problem

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How are the key elements of scientific thinking used in the following scenario?

*While making toast, you notice it fails to pop out of the toaster. Thinking the spring mechanism is stuck, you notice that the bread is unchanged. Assuming you forgot to plug in the toaster, you check and find it is plugged in. When you take the toaster into the dining room and plug it into a different outlet, you find the toaster works. Returning to the kitchen, you turn on the switch for the overhead light and nothing happens.*

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## Unit I - Up Next

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- Strategies for solving chemical problems
- Taking measurements
- Expressing uncertainties in measurements

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The End

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