Introduction to Chemistry

Chemistry

The study of:

- the composition (make-up) of matter
- the changes that matter undergoes

What is matter?

- Anything that:
  - has mass
    and
  - occupies space (volume).

Mass vs Weight

- Mass: a measure of the amount of matter that an object contains. (SI unit kilogram, kg)

- Weight: The force with which the earth pulls on an object. (SI unit Newton, N)

The 5 Branches of Chemistry

- Inorganic
- Organic
- Analytical
- Physical
- Biochemistry

Inorganic Chemistry

- The study of chemicals that do not contain carbon.

Organic Chemistry

- The study of chemicals that contain carbon.
- Origin: study of chemicals in living organisms.

Organic or Inorganic ?

- Sulfuric Acid H_2SO_4
- Methane CH_4
- Hydrochloric Acid HCl
- Ethane C_2H_6

Analytical Chemistry

- Composition of matter.

Ex:
Mass Spectrometer
Gas Chromatograph

http://besg.group.shef.ac.uk/Facilities/Images/gcms.JPG

Physical Chemistry

- The study of :
  - The mechanism
  - The rate
  - The energy transfer

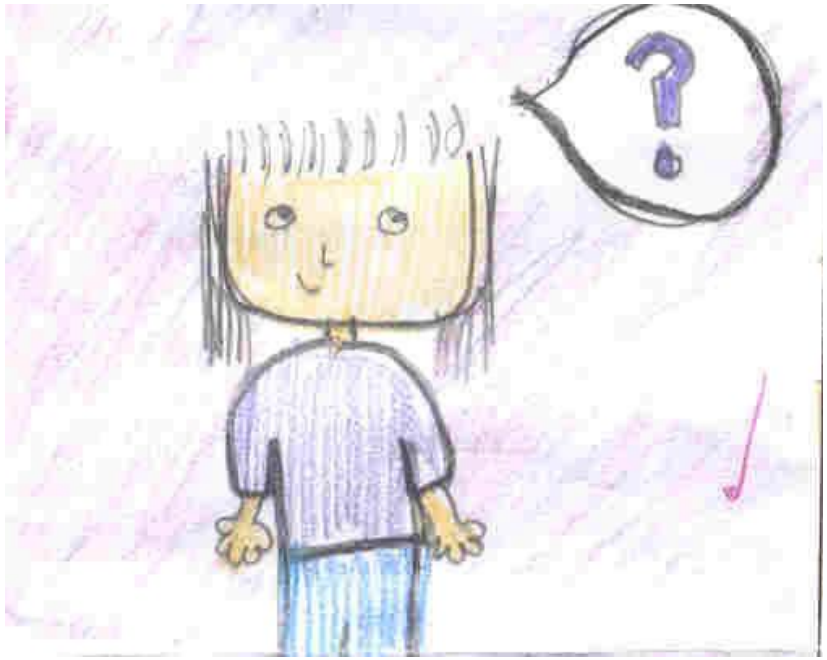
that happens when matter undergoes change.

Biochemistry

- Study of processes that take place in organisms.

Science

- What?
- Why?
- How?
- When?



Science and Technology

- Science → Pure
  - Does not necessarily have an application.
- Technology → Applied
  - Has practical applications in society.
  - Engineering.

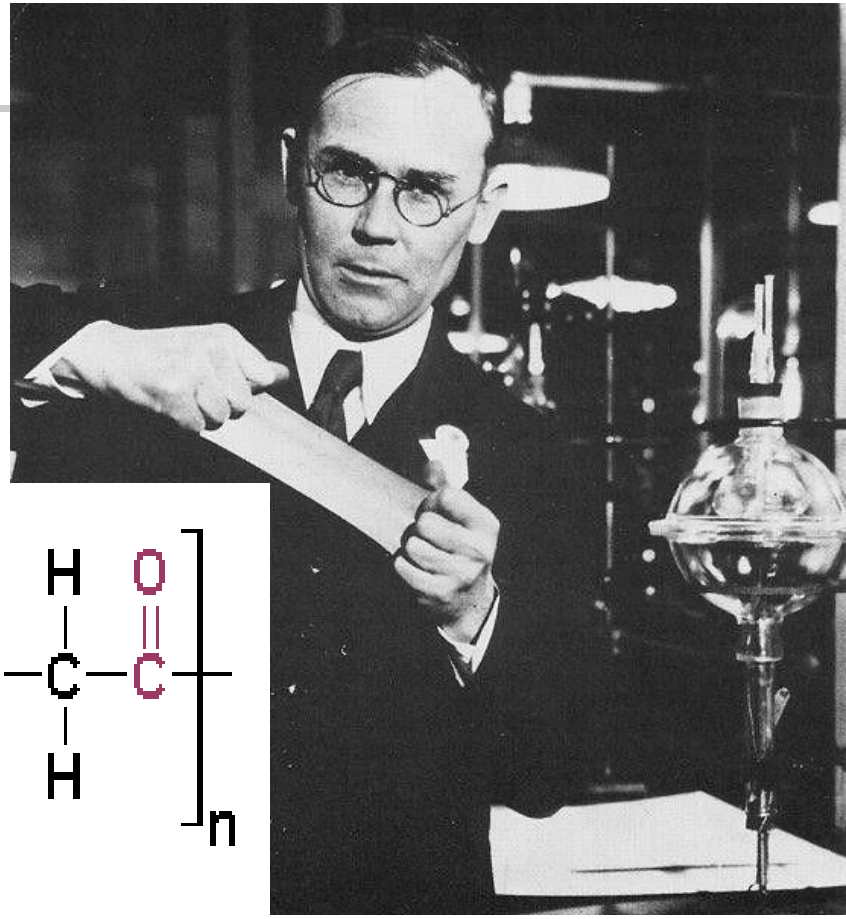
Question: Science or Technology?

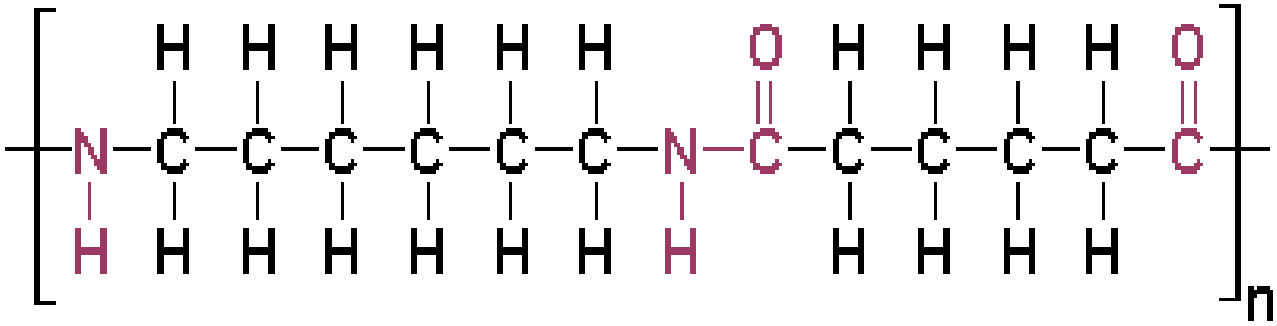
Studying or forming aspirin in a lab in small scale (small amounts).

Question: Science or Technology?

- Producing aspirin tablets so that consumers can use them.

Example: Discovery of Nylon by Wallace Carothers in 1930's





the repeat unit of nylon 6-6

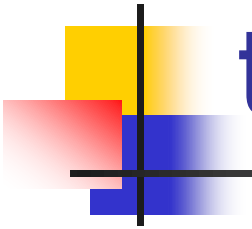
http://www.chemheritage.org/EducationalServices/nylon/nylon.html

http://heritage.dupont.com/touchpoints/tp_1935-2/depth.shtml

Microscopic- Macroscopic

- Micro –(small)
  - Microscopic- objects can be seen with a microscope.
- Macro-(from afar)
  - Macroscopic- objects are seen without a microscope.

Part II – A Brief History and the Scientific Method



Aristotle (Greece, 4th Century BC)

Philosopher who believed that:

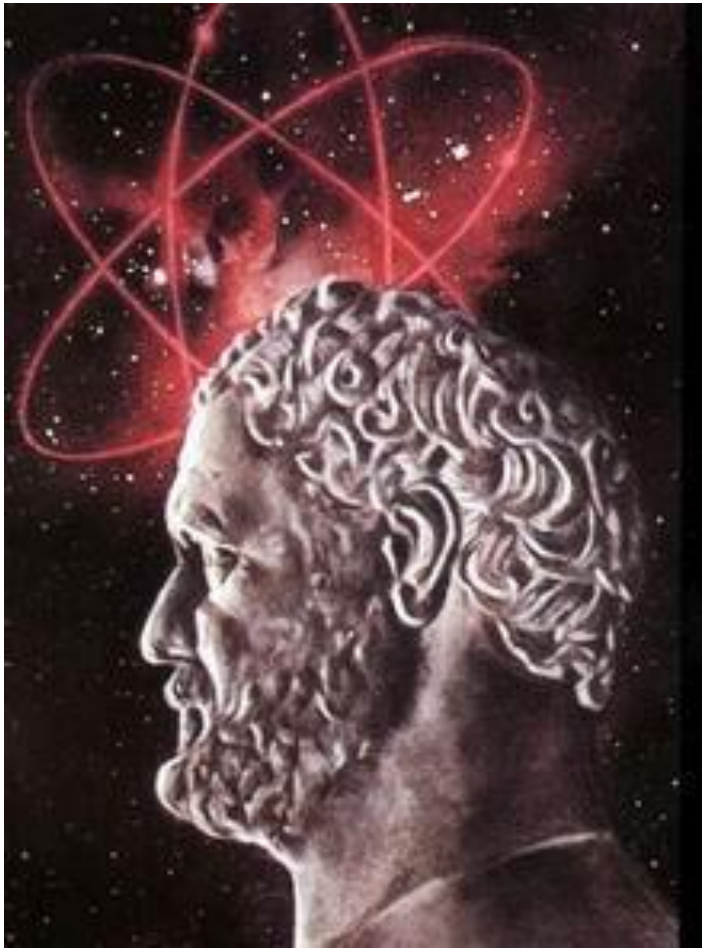
- There are 4 elements:

  earth, water, air, fire.

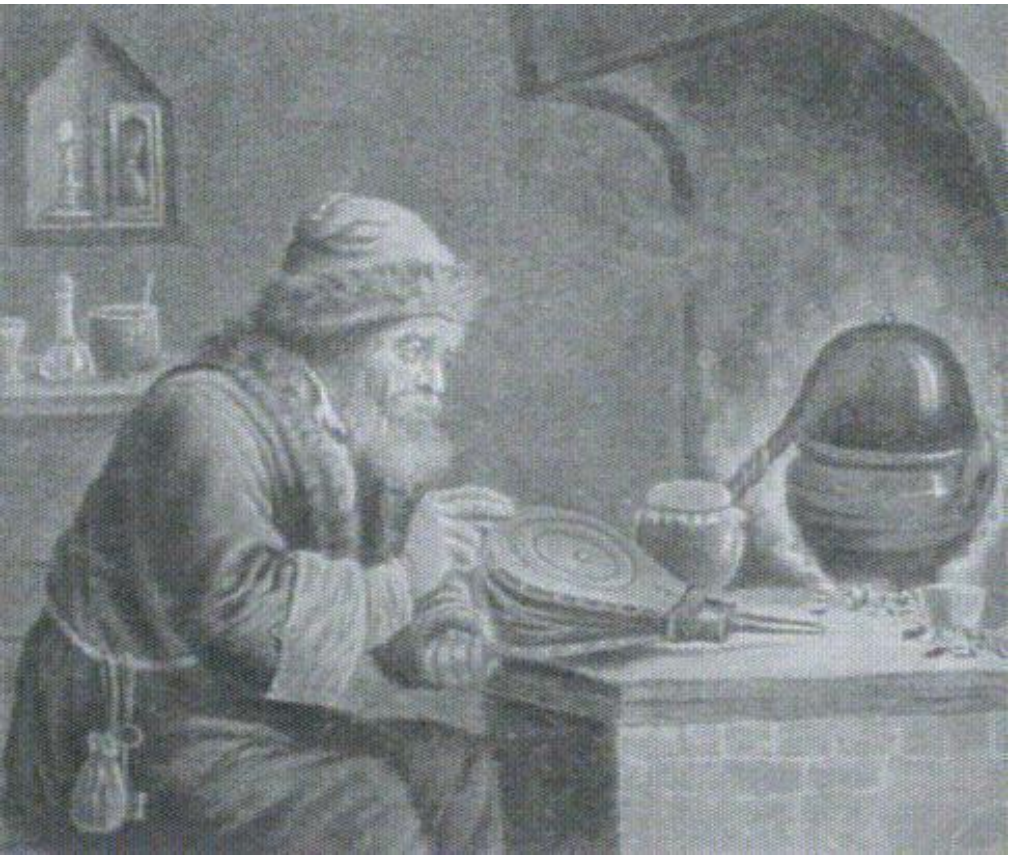
- Matter is perpetually divisible.

Democritus (Greece, 4th Century BC)

- First atomic theory
- Atom (indivisible).



Alchemists (~300BC-1650 AD)
China, India, Arabia, Europe, Egypt



- Aiming to:
  - Change common metals to gold.
  - Develop medicines.
- Developed lab equipment.

Galileo Galilei (Italy 1564 AD)

- Father of the scientific method

(along with the Englishman Francis Bacon 1500's).

Antoine Lavoisier (France 1743-1794)

- Regarded as the Father of Chemistry.
- Designed equipment.
- Used observations and measurements.
- Discovered nitrogen.

Antoine Lavoisier (cont'd)

- Discovered the Law of Conservation of Mass:
  - In a chemical reaction mass is conserved.

Antoine Lavoisier (cont'd)

- Explained burning as reaction with oxygen.
- Old theory: release of "phlogiston".

Question:

- Does an iron nail gain mass or lose mass when it rusts (a form of burning)?

John Dalton (England 1766-1844)

- Atomic theory

Amedeo Avogadro (Italy, 1776-1856)

- **Avogadro's Number 6.02×10^{23}**

- One mole of any substance contains **6.02×10^{23}** particles.

Dmitri Mendeléev (Russia, 1834-1907)

- First Periodic Table of elements.

The Scientific Method

- Steps followed during scientific investigations.

Scientific Method

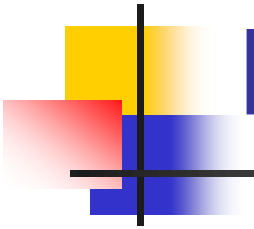
- Observation- recognition of a problem.
- Hypothesis- a proposed explanation of an observation
  - an educated guess
  - must be testable.
- Experiment- a procedure used to test a hypothesis (measurement, data collection, manipulated and responding variables)
- Theory
- Law

Theory

- A well tested explanation for a broad set of observations.
- May use models.
- May allow predictions.
- Theories may change to explain new observations.

Law

- A statement that summarizes results of observations, but does not explain them.
- Changes or is abandoned when contradicted by new experiments.



Note:

- The order of the steps can vary and additional steps may be added.

"No number of experiments can prove me right;

a single experiment can prove me wrong."

Albert Einstein

Part III Math and Chemistry

- Math- the language of Science

Units

- SI Units – International System
  - Basic Units

		mks
Length	(meter)	m
Mass	(kilogram)	kg
Time	(second)	s

- National Bureau of Standards

Solving Word Problems

- Analyze
  - List knowns and unknowns.
  - Devise a plan.
  - Write the math equation to be used.
- Calculate
  - If needed, rearrange the equation to solve for the unknown.
  - Substitute the knowns with units in the equation and express the answer with units.
- Evaluate
  - Is the answer reasonable?