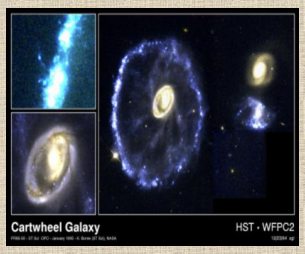
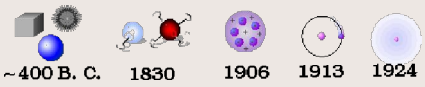
Atomic Models

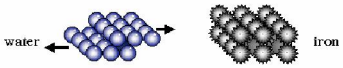
Democritus to Rutherford





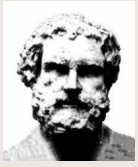
Do Atoms Have Internal Structure?

- Demokritos: Atoms determine properties



- Dalton: Atoms determine composition

Democritus (460—370 BC)



- Greek Philosopher
- Atomism
- *Nothing exists but atoms and empty space; everything else is opinion.*
- Atom comes from *atomos* meaning *uncuttable.*

Democritus Atomic Theory

1. All matter consists of *INVISIBLE PARTICLES*.....called atoms
2. Atoms are *INDESTRUCTIBLE & UNCHANGEABLE*
3. A VOID (empty space) exists *between* atoms
4. Atoms are *SOLID*
5. Atoms are *HOMOGENEOUS*.....(no internal structure)
6. Atoms *DIFFER* in size, shape, mass, position, arrangement.....

- *Solids are made of small, pointy atoms.*
- *Liquids are made of large, round atoms.*
- *Oils are made of very fine, small atoms that can easily slip past each other.*
- Sweet things are made of smooth atoms, bitter things of sharp atoms

John Dalton (1766--1844)

- *A New System of Chemical Philosophy*
- Developed the 1st *useful* Atomic Theory
- Good at experiments
- 1st to associate atoms with *stoichiometry*

Dalton's Atomic Model

1. All matter consists of *TINY PARTICLES*
2. Atoms are *INDESTRUCTIBLE & UNCHANGEABLE*
3. Elements are characterized by *ATOMIC MASS*
4. When elements react, their atoms combine in WHOLE NUMBER RATIOS

Dalton's Laws

- Law of Constant Composition (aka Law of Definite Proportions)

  for a given compound, the composition is always the same:

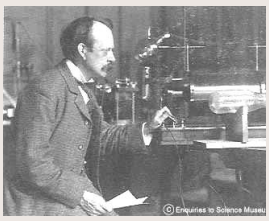
  H_2O CO_2 CH_4

- Law of Multiple Proportions

  different compounds may be formed from the same elements in different, but fixed, ratios:

  H_2O & H_2O_2 CO_2 & CO CH_4 & C_2H_6

J. J. Thomson (1856--1940)



Discovered electrons in 1891

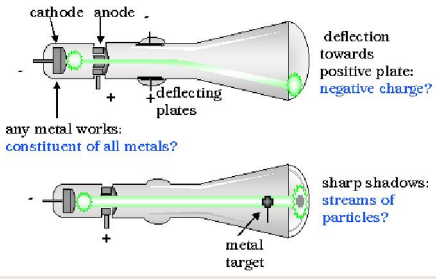
Cathode ray tubes

Plum Pudding Atomic Model

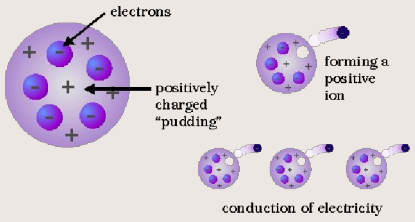
A Cathode Ray Tube

Probing Atomic Structure:

Cathode Rays



Thomson's Plum Pudding Atom

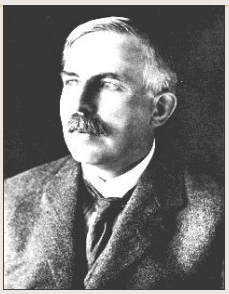


Rutherford (1871--1937)

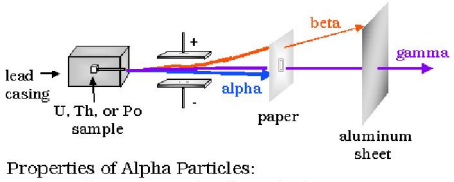
Discovered the nucleus in 1911

Gold Foil Experiment

Planetary Atomic Model



Probing Atomic Structure: Alpha Rays

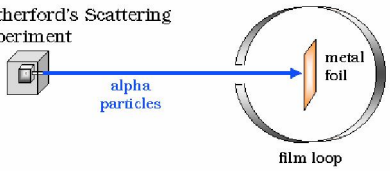


Properties of Alpha Particles:

- much more massive than electrons
- positively charged
- expose photographic film

Discovery of the Nucleus

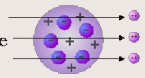
Rutherford's Scattering Experiment



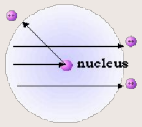
Rutherford's explanation for
both
large- and small-angle scattering,
was the
nucleus

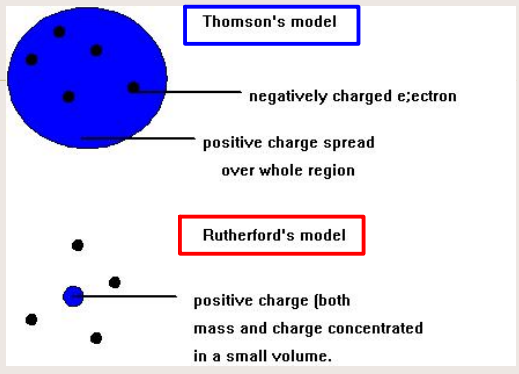
The Nuclear Atom

- **Thomson's Atom**
  - diffuse mass and charge

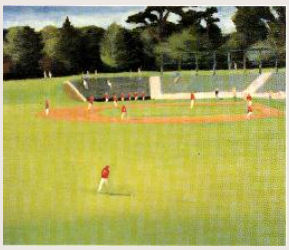


- **Rutherford's Atom**
  - concentrated mass and positive charge at the nucleus
  - electrons roam empty space around the nucleus





Empty space!!

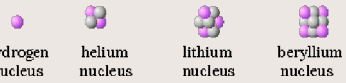


If an atom were the size of a baseball stadium,
The nucleus would be the size of a PEA

Structure of the Nucleus

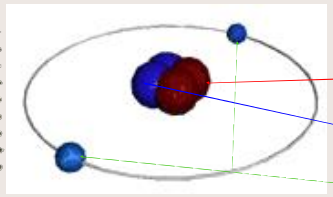
- nuclei are composed of "nucleons": protons and neutrons

	Symbol	Charge	Mass, kg	Mass, amu
electron	e^-	-1	9.10953×10^{-31}	0.000548
proton	p^+	+1	1.67265×10^{-27}	1.007276
neutron	n	0	1.67495×10^{-27}	1.008665



hydrogen nucleus | helium nucleus | lithium nucleus | beryllium nucleus

A Model of Helium

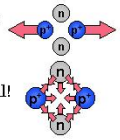


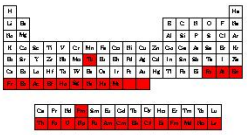
Elements Chart

Element Symbol	Atomic #	Atomic Mass	Mass #	# Protons	# Electrons	# Neutrons
H	1	1.008	1	1	1	0
He	2	4.003	4	2	2	2
O	8					
N	7					
C	6					
F	9					
P	15					
Sn	50					
C-14	6					

Nuclear Tug-of-War

- electrostatic force pulls nuclei apart
- strong nuclear force holds nuclei together
  - range ~ 10^{-13} cm: nuclei are small!



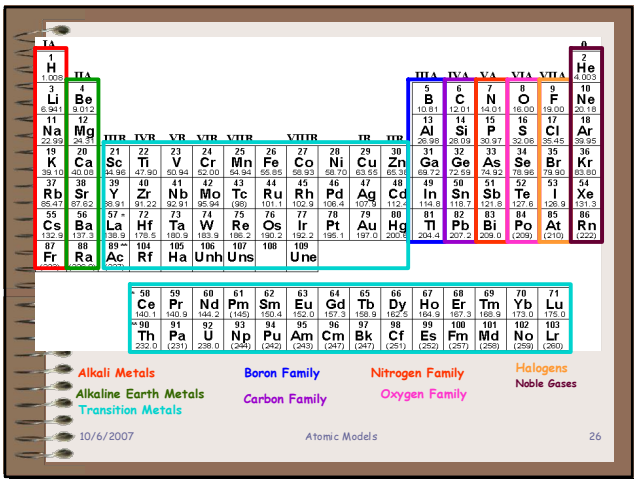


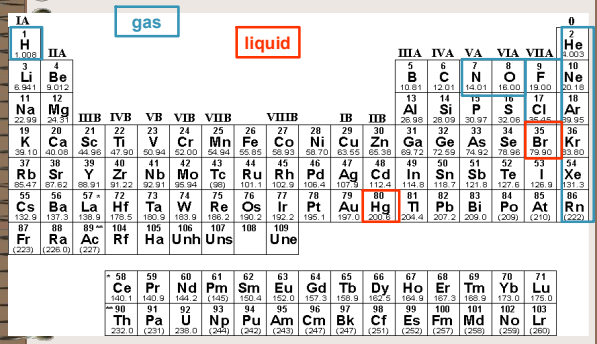
large nuclei tend to be unstable

Isotopes

Same Atomic Number, Different Atomic Mass
Same # of Protons, Different # of Neutrons

Hydrogen	1 proton, 0 neutrons
Deuterium (heavy hydrogen)	1 proton, 1 neutron
Tritium (heavier hydrogen)	1 proton, 2 neutrons
Carbon-12	6 protons, 6 neutrons
Carbon-13	6 protons, 6 neutrons





Source of Images and Text

http://antoine.frostburg.edu/chem/senese/101/atoms/dalton.shtml
http://dbhs.wvusd.k12.ca.us/Rutherford-Model.html