The History of Atomic Theory i.e. the history of the development of thought about what an atom is.

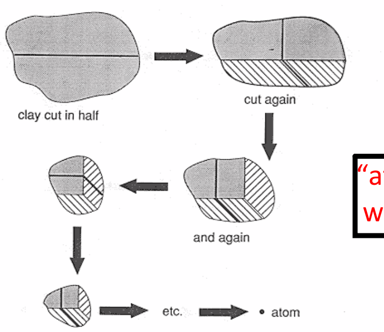
1st timeframe: around 5 B.C. : This was the time of the Ancient Greeks (in Athens, Greece).

During the time of the Ancient Greeks people spent a lot of time debating the question:

"What is the nature of matter?"

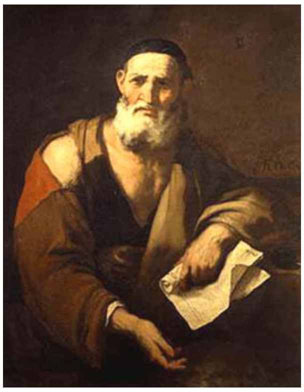
We will be looking at the beliefs of three specific Ancient Greek philosophers:

1. Leucippus: he coined (invented) the term "atom". He defined the atom as a particle that is so small that it could not be divided anymore.



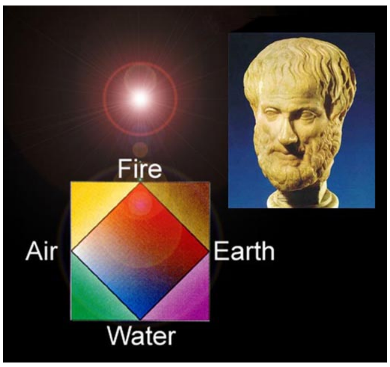
Leucippus' concept of the atom

"atomos" is a Greek word which means "indivisible"



Leucippus Lived during 1st half of the 5th century BC

2. Aristotle: he believed that all matter is made up of four basic elements: earth, air, water, and fire. Aristotle thought that various substances (e.g. a tree or a stone differ from each other because they contain different proportions of the four basic elements.



Aristotle (384 BC - 322 BC)

3. Democritus: Democritus was Leucippus' student and he built on Leucippus' ideas.

Democritus developed the first atomic theory (theory about the nature of atoms). Therefore, many consider him to be the father of modern science.

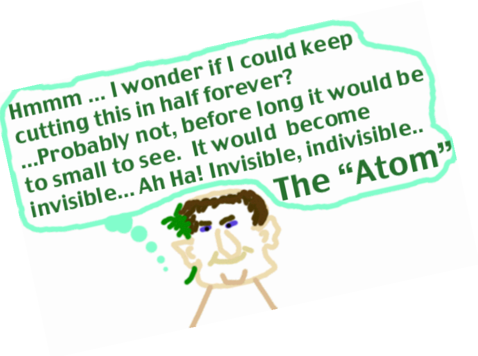
Democritus agreed with Leucippus' idea of what an atom is. However, he went further to make the following assertions:

i) Atoms are always moving.

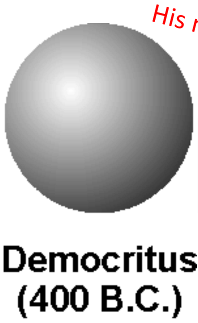
ii) There are gaps between atoms.

iii) Atoms combine with each other in different ways.

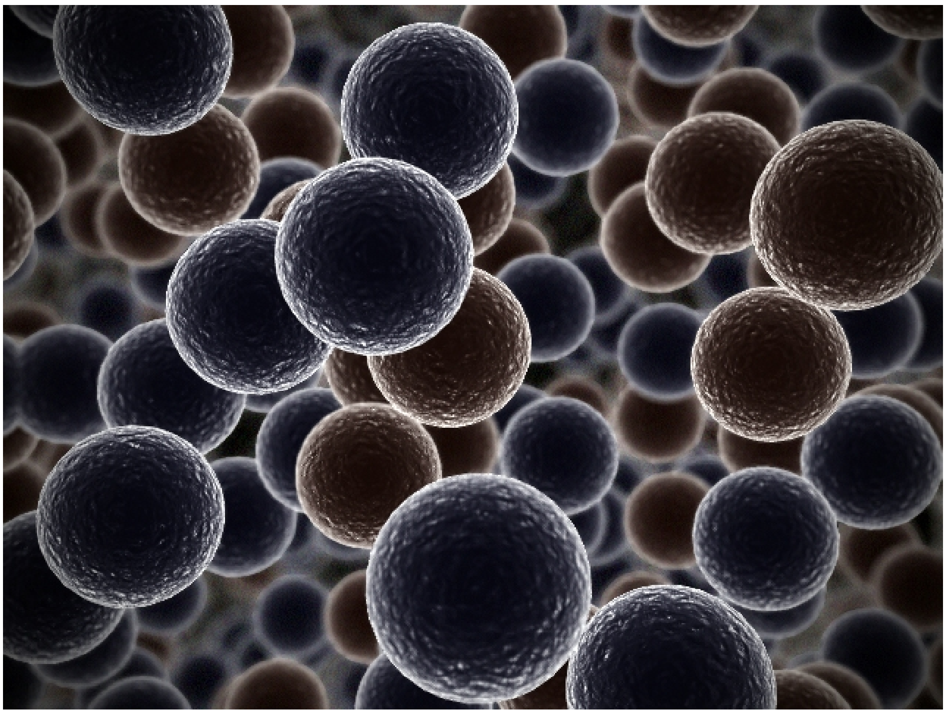
Democritus 460 BC - 370 BC



His model of what one atom looks like.

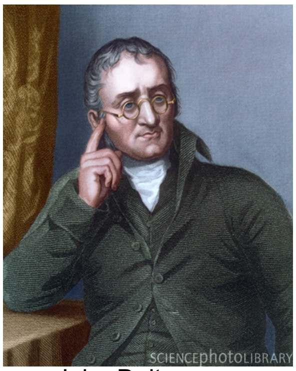


Democritus' Atomic Model :

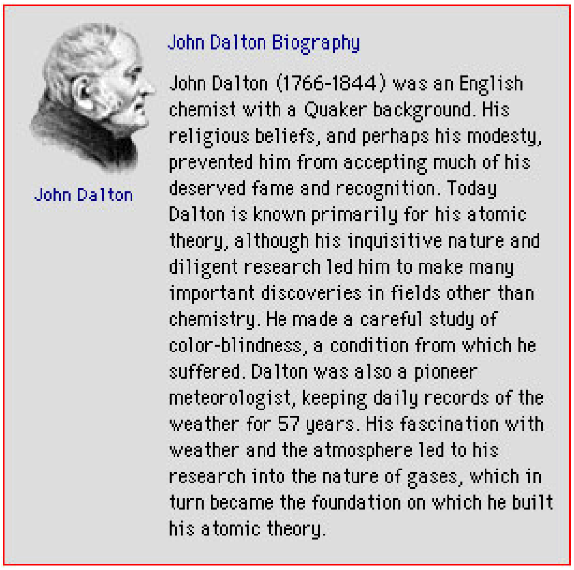


<u>2nd Timeframe: John Dalton (1766 - 1844)</u>

Dalton conducted his work around the time of the Industrial Revolution.
During this time there was new interest in the structure of matter.



John Dalton



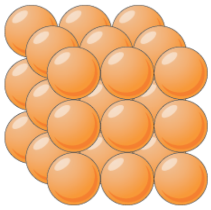
John Dalton Biography

John Dalton

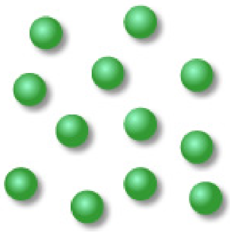
John Dalton (1766-1844) was an English chemist with a Quaker background. His religious beliefs, and perhaps his modesty, prevented him from accepting much of his deserved fame and recognition. Today Dalton is known primarily for his atomic theory, although his inquisitive nature and diligent research led him to make many important discoveries in fields other than chemistry. He made a careful study of color-blindness, a condition from which he suffered. Dalton was also a pioneer meteorologist, keeping daily records of the weather for 57 years. His fascination with weather and the atmosphere led to his research into the nature of gases, which in turn became the foundation on which he built his atomic theory.

1. Dalton defined the following terms:

<u>element</u>: one atom or a collection of atoms

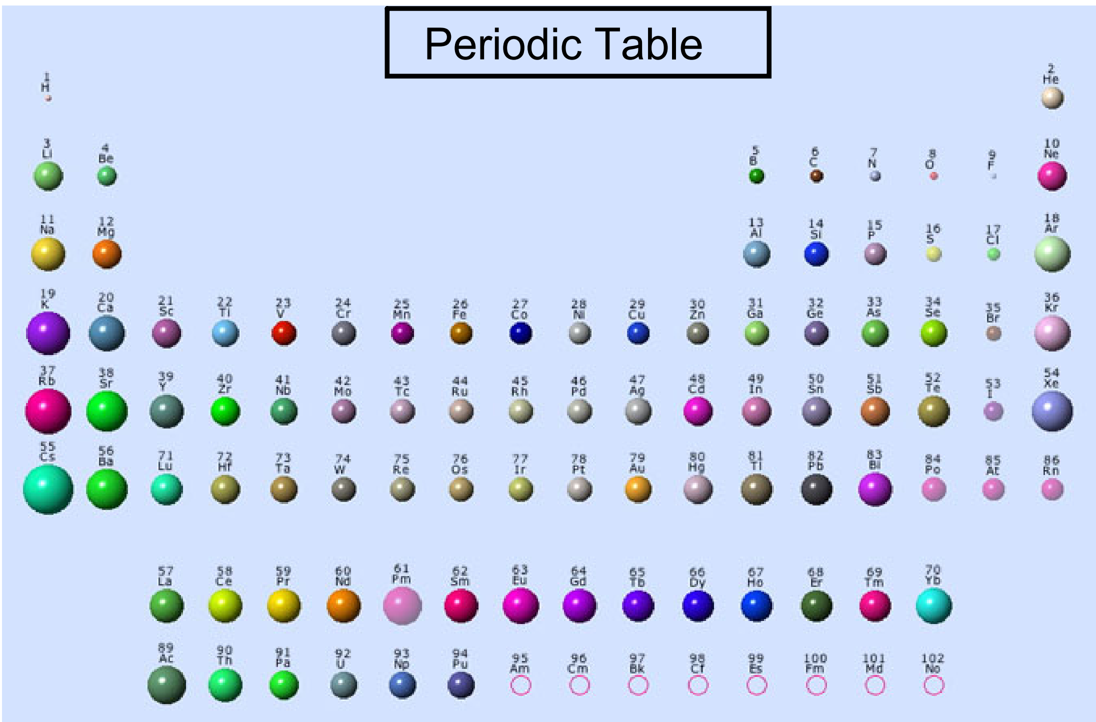


e.g. a piece of iron is made of iron atoms



e.g. a sample of helium gas contains helium atoms

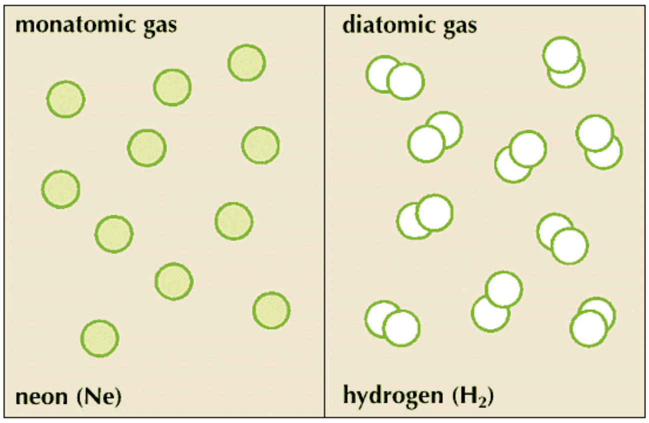
The elements are the substances on the periodic table:



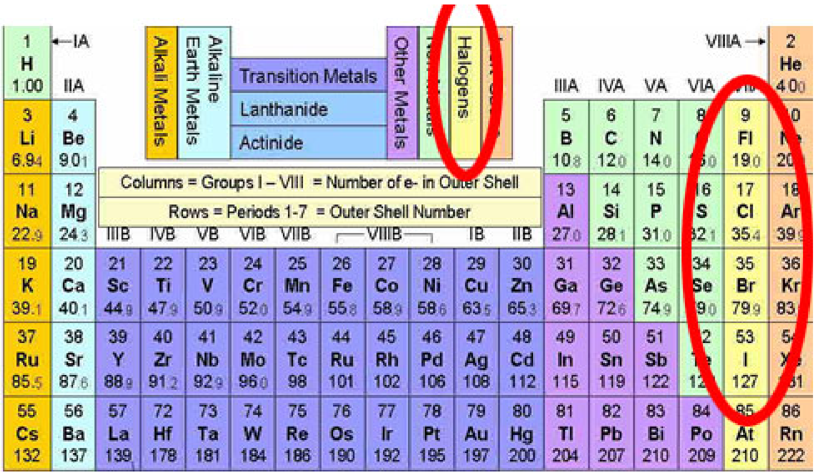
Elements can be monoatomic or diatomic...

Monoatomic: elements in which atoms exist individually.

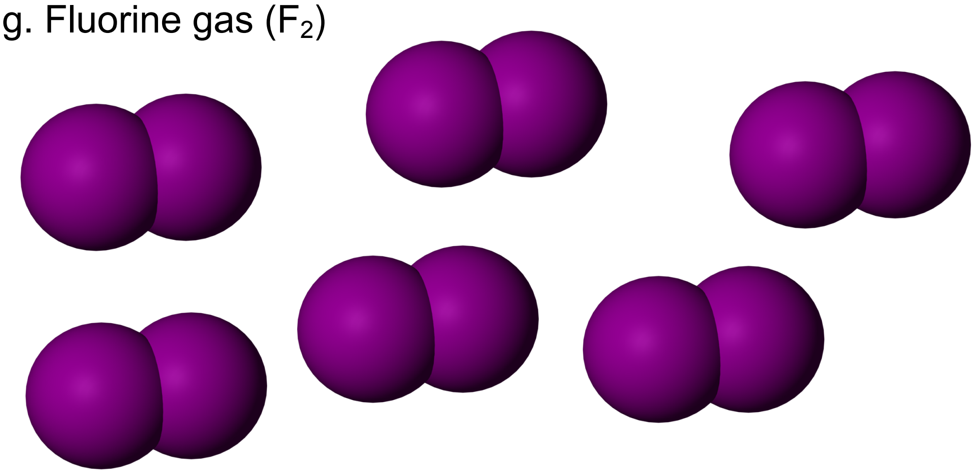
Diatomic: elements in which atoms exist in pairs.



The following elements are diatomic: Hydrogen, Oxygen, Nitrogen, and the Halogens:



e.g. Fluorine gas (F_2)

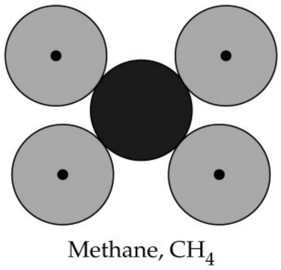


compound: consists of molecules; each molecule contains more than one type of atom (more that one element).

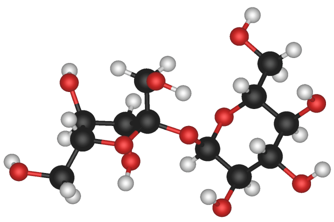
e.g.s:

model of an NaCl molecule
NaCl is a compound

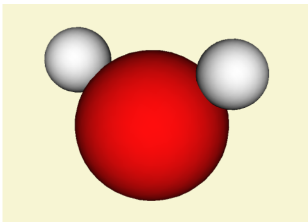
one methane molecule
Methane is a compound



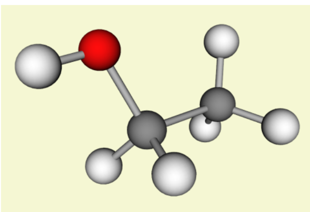
one sucrose molecule ($C_{12}H_{22}O_{11}$)
Sucrose is a compound

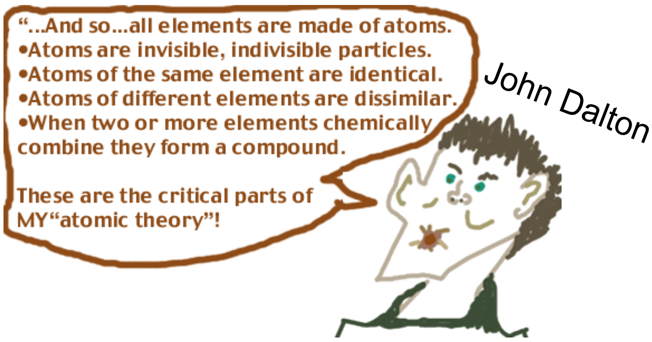


one water molecule (H_2O)
Water is a compound

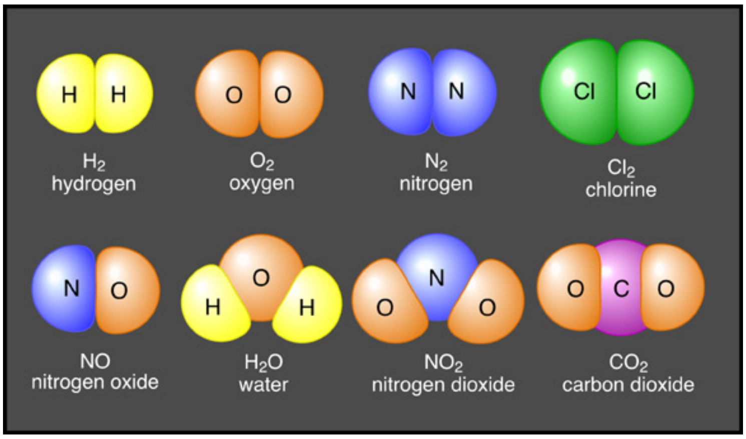


one ethanol molecule (CH_3CH_2OH)
Ethanol is a compound





So, there can be molecules of an element (top row of molecules below) or molecules of a compound (bottom row of molecules below):



Dalton's other contributions...

2. Dalton stated that atoms of a specific element are identical and that they have the same mass.

   e.g. the mass of one carbon atom = mass of another carbon atom

3. Dalton stated that different atoms (of different elements) have different masses.

   e.g. the mass of one carbon atom $\neq$ the mass of one sodium atom

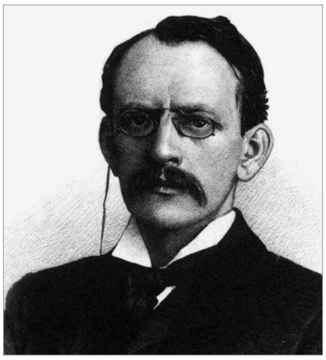
4. Dalton devised a system for classifying the known elements based on their relative masses. He assigned hydrogen (the lightest element) a mass of 1 u, and determined the masses of all the other elements compared to the mass of hydrogen.

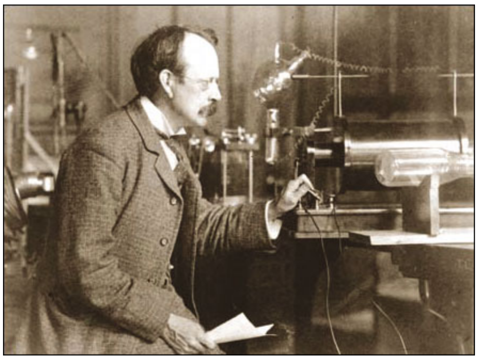
   e.g. since the mass of one carbon (C) atom is 12 times the mass of a hydrogen atom (H), C was assigned a mass of 12 u.

Dalton gave no description of the inside of an atom.

We will now see scientists start to theorize about what the inside of an atom looks like….

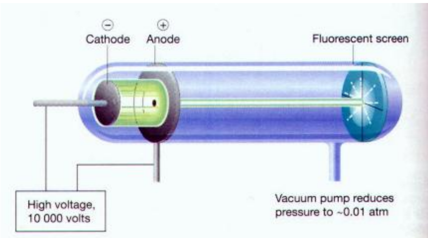
3rd Timeframe: Sir Joseph Thomson (1856-1940)

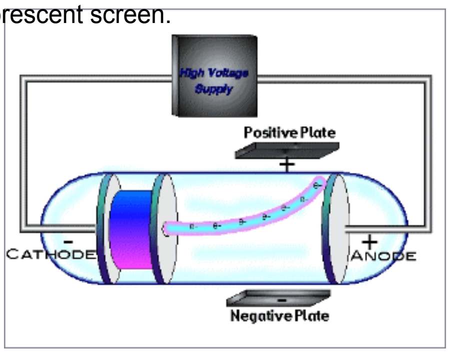




Thomson conducted his experiments with cathode ray tubes.

Cathode ray tube: an electric current flows between two electrodes in a vacuum tube. The current flows from the cathode to the anode. Part of the current goes through a small triangular hole in the anode and produces a triangular light spot on a fluorescent screen.





Thomson brought a magnet near the cathode ray tube and noticed that it made the rays in the tube bend toward the positive pole of the magnet. This showed that the particles which make up these rays are negatively charged.

According to Thomson, **this confirmed the existence of electrons.**

Thomson's claim to fame:
He confirmed the existence of electrons

Electrons are negatively charged particles in an atom.

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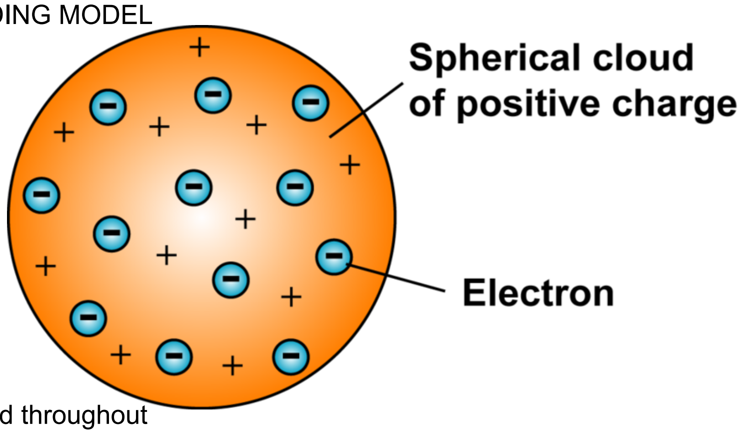
Thomson's Model of the Atom (What one Atom looks like):

It is called the PLUM PUDDING MODEL



Atom is dense; solid throughout.

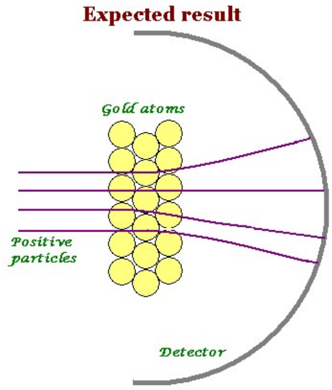
Positively charged "batter"

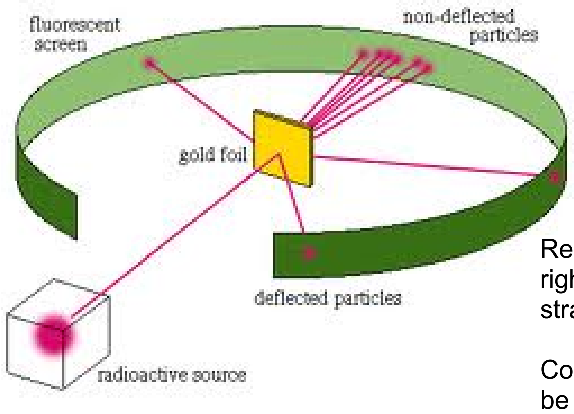
Negative electrons (raisins) scattered throughout

Amount total positive charge = Amount total negative charge

4th Timeframe: Ernest Rutherford (1871 - 1937)

Rutherford bombarded a thin sheet of gold foil (whose atoms are heavy) with tiny fast-moving particles (helium nuclei).





Result: 99.9% of the particles went right through the gold foil in a straight path.

Conclusion: Most of the gold atom must be AIR. If it was dense (like Thomson suggested in his Plum Pudding Model) then the particles would have been reflected off the gold foil.

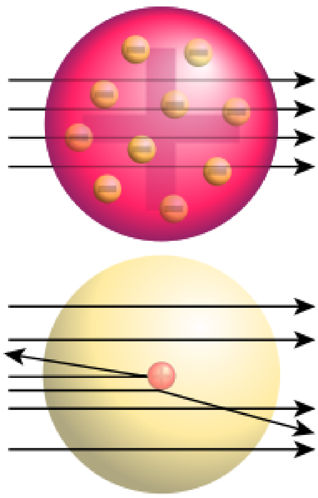
Rutherford's Conclusions:

1. Most of the atom is empty space.

2. The atom's mass is concentrated in a very small nucleus with a strong positive charge.

3. A thick cloud of very light electrons surrounds the nucleus.

4. The nucleus is very dense.

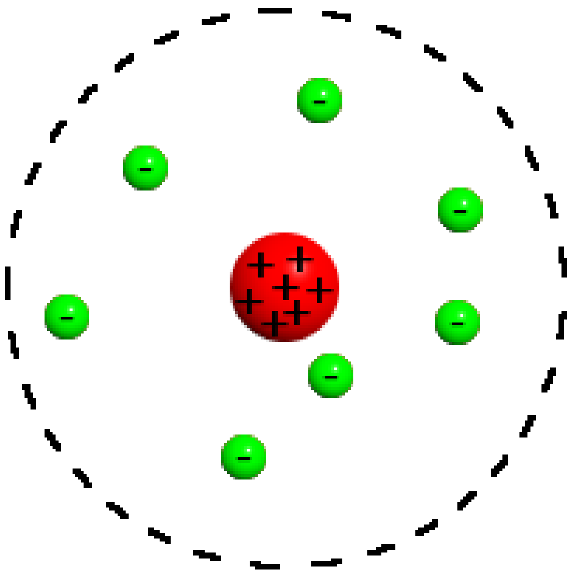


Rutherford's Claim to Fame: He was the first to suggest the existence of POSITIVELY charged PROTONS in a positively charged NUCLEUS.

Protons are positively charged particles which are found inside the nucleus.

p^+ p^+ p^+ p^+ p^+ p^+ p^+

Rutherford's Model of the Atom:



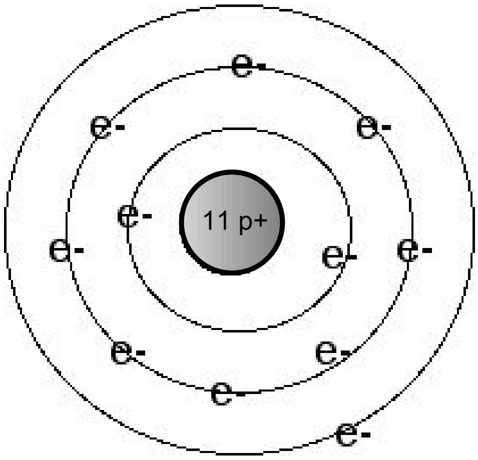
Dense positively charged nucleus

Negatively charged electrons move outside the nucleus.

Most of the atom is empty space.

Total + charge = total - charge

4th Timeframe: Niels Bohr (1885-1962)



Bohr stated that electrons revolving around the nucleus are arranged in fixed energy levels or shells (similar to the orbit of planets around the sun).

The first orbit can hold a maximum of 2 electrons; after that each orbit can hold up to a maximum of 8 electrons. Inner orbits must fill before electrons can enter outer orbits.

Bohr stated that the distribution of electrons around the nucleus affects the ability of an atom to react with other atoms to form compounds.

5th Timeframe: James Chadwick (1891 - 1974)

Chadwick's Claim to Fame: He discovered the neutron

Neutrons: like protons, neutrons are also in the nucleus.
Neutrons are neutral; they have no charge.
Neutrons help to hold the nucleus together.

A thirsty, little **neutron** walks into a restaurant and orders a drink.
The chef -- who evidently has excellent vision and hearing --
turns, mixes the drink, and when finished sets it on the table for the little neutron.
The little neutron takes a very small sip, smiles, and says to the chef,
"How much do I owe you?"
The chef smiles back and responds, "For you, **no charge**."

Chadwick's model is also called the
CURRENT SIMPLIFIED MODEL....

This model of the atom corresponds to what scientists currently believe to be true!

Current Simplified Model of the Atom