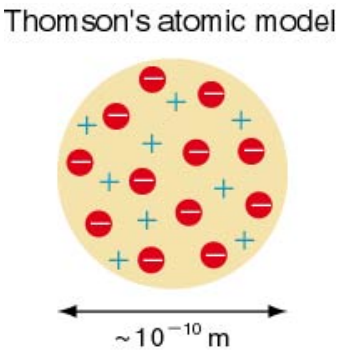
Nature of the Atom

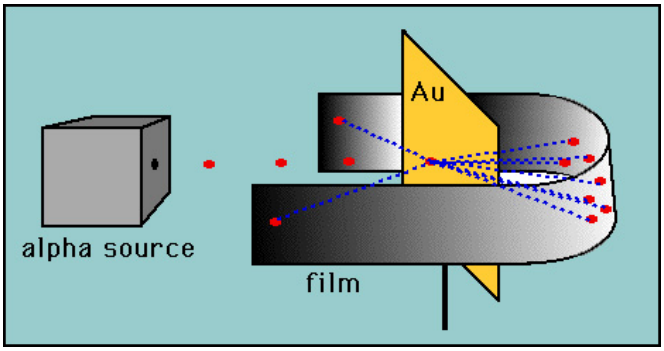
The **plum pudding model** of the atom by J. J. Thomson, who discovered the electron in 1897, was proposed in 1904 before the discovery of the atomic nucleus.

In this model, the atom is composed of electrons surrounded by a soup of positive charge to balance the electron's negative charge, like negatively-charged "plums surrounded by positively-charged "pudding ".

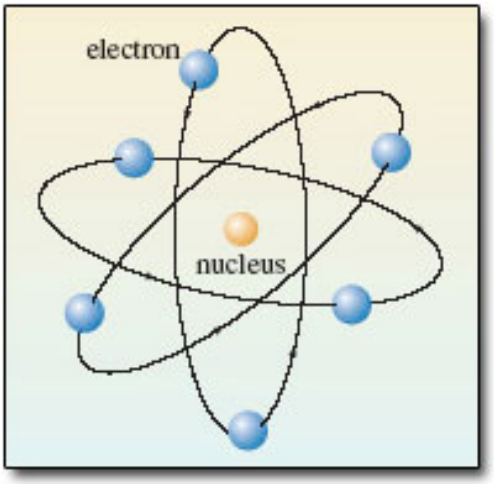
Instead of a soup, the atom was also sometimes said to have had a "cloud" of positive charge.



Rutherfordtested Thomson's hypothesis by devising his "gold foil" experiment. Rutherford reasoned that if Thomson's model was correct then the mass of the atom was spread out throughout the atom. Then, if he shot high velocity alpha particles (helium nuclei) at an atom then there would be very little to deflect the alpha particles. He decided to test this with a thin film of gold atoms. As expected, most alpha particles went right through the gold foil but to his amazement a few alpha particles rebounded almost directly backwards.



These deflections were not consistent with Thomson's model. Rutherford was forced to discard the Plum Pudding model and reasoned that the only way the alpha particles could b deflected backwards was if most of the mass in an atom was concentrated in a nucleus.



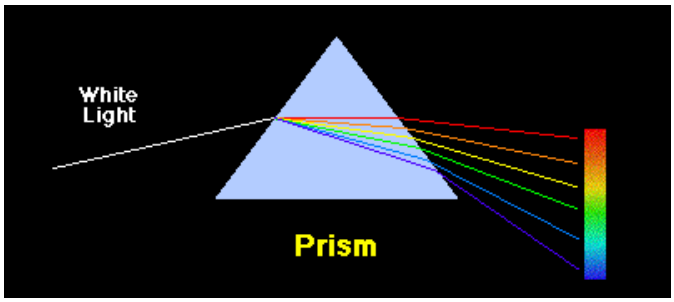
Rutherford's Atom

Electrons can not be stationary or they would be pulled into the nucleus.

Electrons must revolve around the nucleus.

Bohr Model of the Atom
(attempt to explain line spectra)

There are differences in the spectral lines we see depending on what the light is passing through.



Continuous Spectrum

White light passing through prism creates the rainbow we are familiar with.

Light passing through a gas like hydrogen will create an **absorption** spectrum as certain wavelengths of the light are absorbed.

Light created from a hot gas (like hydrogen) will create an **emission spectrum**, as only certa wavelengths of light are emitted.

Why does this happen?

http://csep10.phys.utk.edu/astr162/lect/light/absorption.html

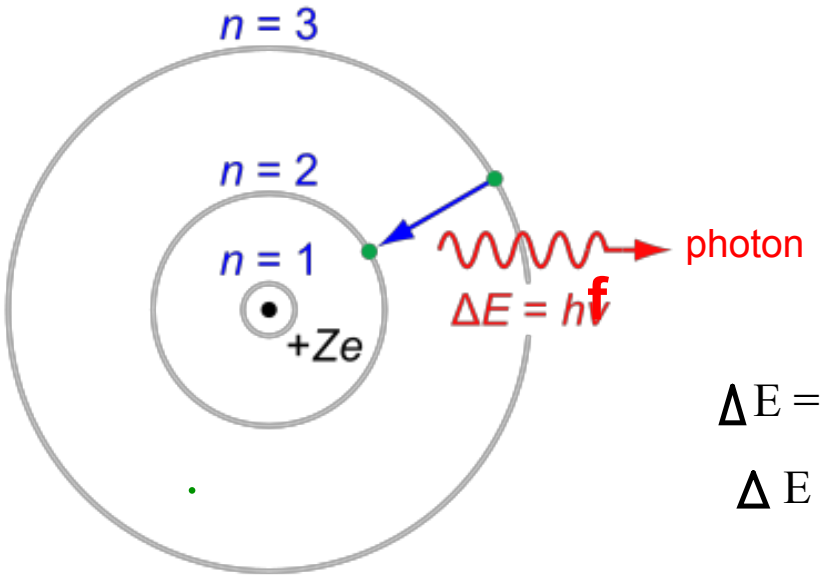
Bohr's Atom:
Neils Bohr explained the spectral lines observed in the emission of light from hydrogen with his **Bohr model of the atom**. *This model is a synthesis of classical and quantum concepts.*

(1) Energy is quantized so only certain values of energy can exist in a H atom.

(2) Energy levels correspond to electron orbits. Larger orbit = more energy.

(3) Photons are only emitted when electrons move from a larger orbit (more energy) to smaller orbit (less energy).

The different lines in the spectra are explained by the different energies between orbits.



$\Delta E = E_i - E_f$

$\Delta E = hf$

http://www.upscale.utoronto.ca/PVB/Harrison/BohrModel/Flash/BohrModel.html

Bohr's radius:

The radius of these different energy levels can be calculated using

$r_n = (5.29 \times 10^{-11}\ m)\ n^2$ Where n = 1,2,3,... and is the energy level

when n = 1 the electron has the lowest orbit, and this is called the **ground state**.

Energy of the Bohr Radius:

The energy of these energy levels or orbits can be obtained from

$$E = -13.6 \text{ eV} / n^2$$

or

$$E = -2.18 \times 10^{-18} \text{ J} / n^2$$

Why negative? This is the energy required to remove an electron from that level to infinit
If the electron is removed from the ground state this is called the **ionization energy**, so if you
add 13.6 eV of energy to the electron orbiting a Hydrogen atom, you create a Hydrogen io
H+.

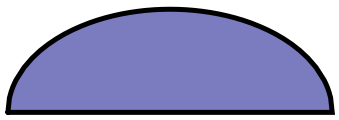
Emitted Light

Once we know the energy released when an electron drops down a level, we can use E = hf to determine the frequency (colour) of the light we see.

An electron dropping from n = 3 to n = 2 releases 1.89 eV of energy, which corresponds to red light. (E = hf). If the e drops from the 5^{th} to the 2^{nd} energy level it emits a 2.86 eV photon, which is in the blue region of the spectrum.

Ex. 1 Calculate the radius of the second orbit of the H atom.

Ex. 2. Calculate the energy of the 2nd energy level of the H atom.



Ex. 3. An electron goes from the 3rd energy level to the the 2nd in Hydrogen. What is the wavelength of light emitted?

Wksht

Luminous Phenomenon

Fluorescence energy is absorbed
electrons change energy levels
electrons fall to lower level giving of energy as photons of light
electrons give off less energy than they absorbed
ex. fluorescent tubes

Phosphorescence energy is absorbed
electrons fall back to their original energy level giving off photons of light
ex. glow in the dark stars