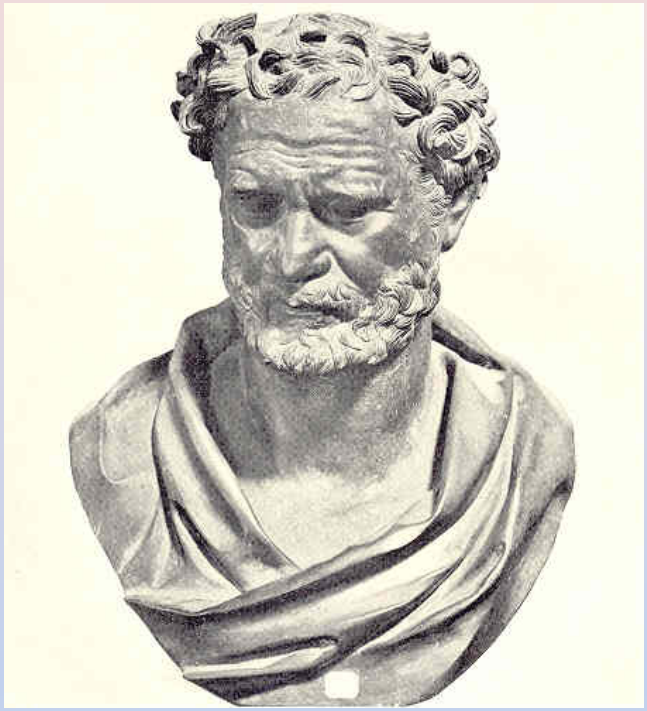
Introduction to the Atom and Atomic Models



DEMOCRITUS

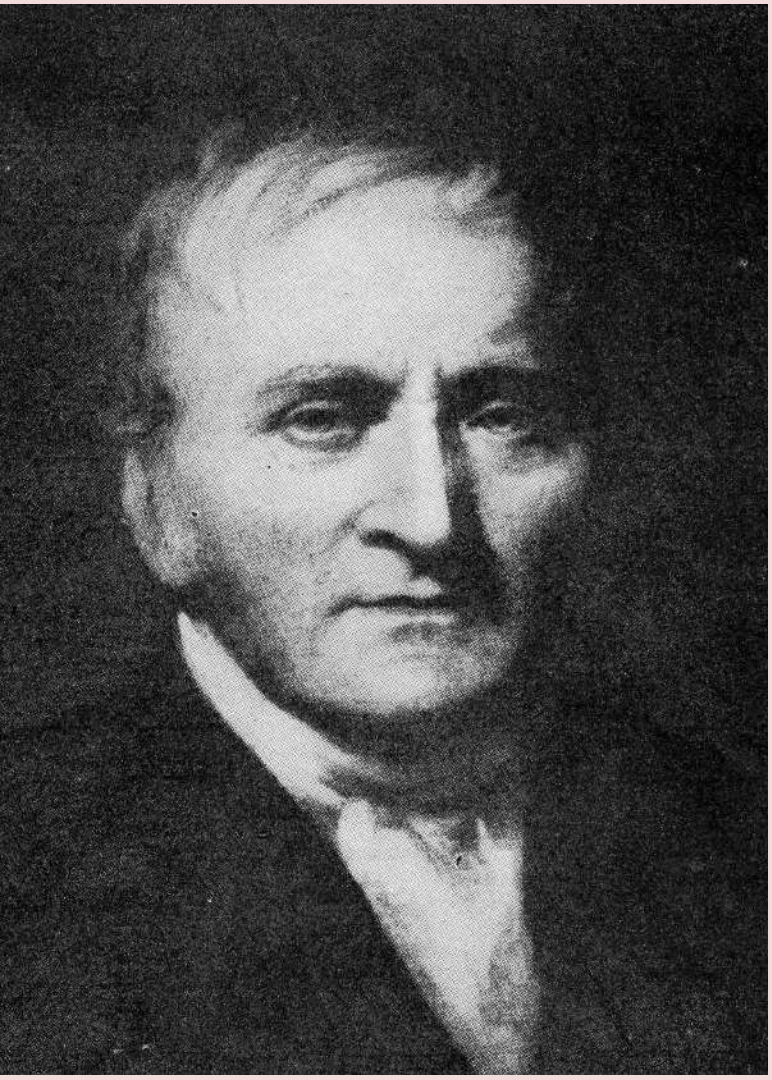
400 BC

Democritus believed all things consisted of tiny indivisible units.

He called these tiny units he called atomos. The Greek word for “can not be cut” or “indivisible”

Ancient philosopher: Father of the Atom

John Dalton (1799)



→ Developed what is considered to be the 1st Atomic Theory

→ Was born into a modest Quaker family in England

→ Began lecturing in public at the age of 12

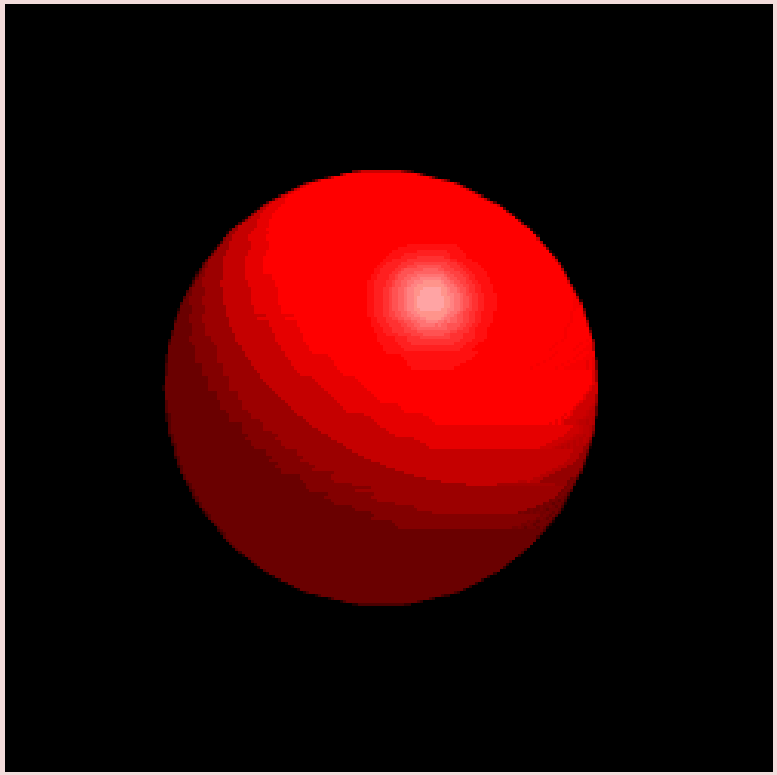
Dalton’s Model (1799)

- **Dalton's model** was that the atoms were tiny, indivisible, indestructible particles and that each one had a certain mass, size, and chemical behavior that was determined by what kind of element they were.

Dalton's Model

Dalton's model of the atom was similar to a tiny billiard ball.

Dalton's model of the atom was solid and had no internal structure.



Dalton's Atomic Theory

- **elements consisted of tiny particles called atoms**.
  - **all atoms of an element are identical**
  - **atoms of each element are different from one another; they have different masses.**
  - **compounds consisted of atoms of different elements combined together.**
  - **chemical reactions involved the rearrangement of combinations of those atoms.**

Flaws in Dalton's Model

- Dalton's falsely believed that the atom was the most fundamental particle.
  - We now know the atom is made up of even smaller particles we call the proton, neutron and electron.
- Dalton's theory could also not account for the formation of ions (charged particles)

Daltons Atomic Model Summary

- Called: Billiard Ball Model
- Could account for
  - Atoms of different atomic masses
  - Elements were tiny particles
- Could NOT account for
  - Though atom was smallest particle
  - Did not have an internal structure
  - The formation of charged particles

John J. Thomson (1897)

- Discovered the electron using the Cathod Ray Tube (CRT)

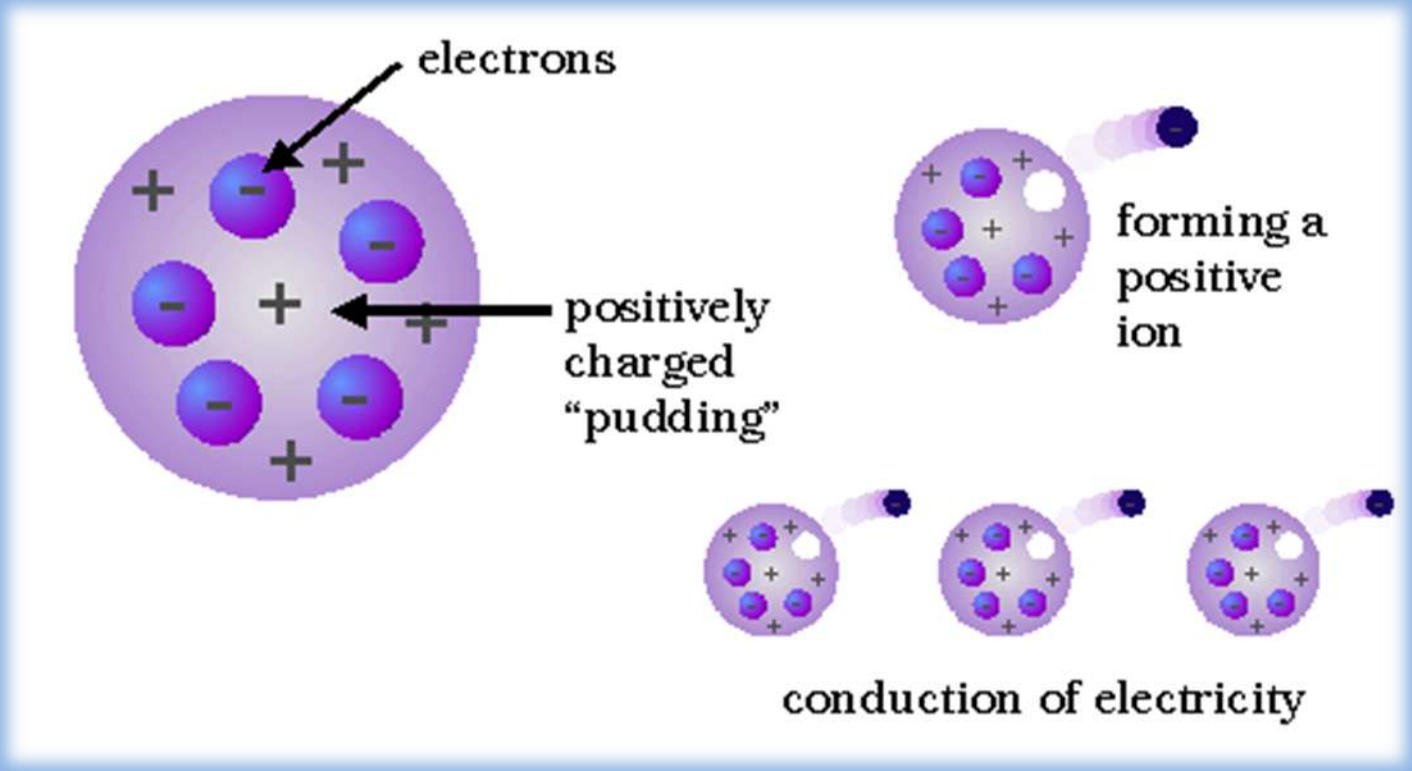
- Thomson found that the beam of charge in the CRT was attracted to the positive end of a magnet and repelled by the negative end.

Thomson's Hypothesis

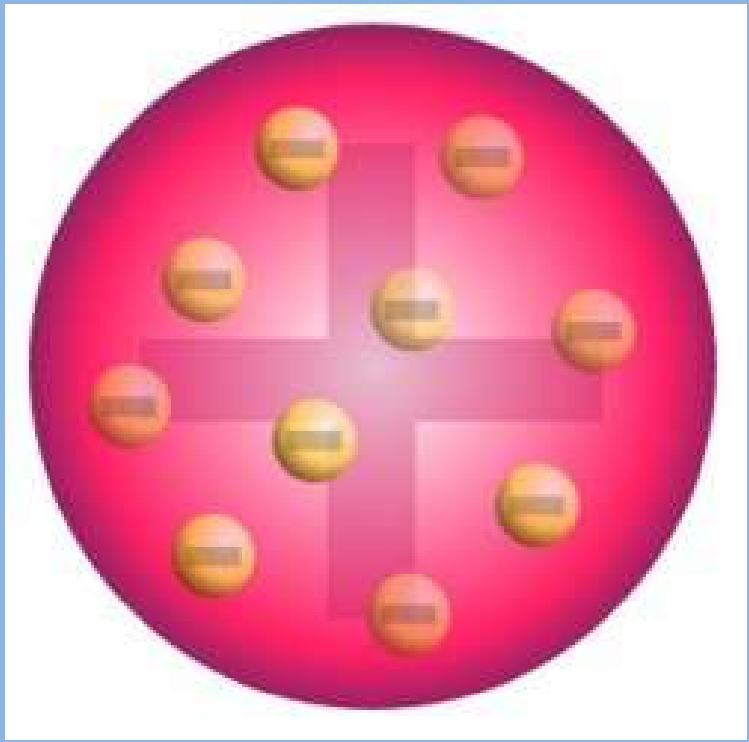
- Concluded that the cathode beam was a stream of negative particles (electrons).
- He tested several cathode materials and found that all of them produced the same result.
- He also found that the charge to mass ratio was the same for all electrons regardless of the material used in the cathode or the gas in the tube.
- Thomson concluded that electrons must be part of all atoms.

Thomson's atomic model

- Called the "plum-pudding" it was the most popular and most wildly accepted model of the time.

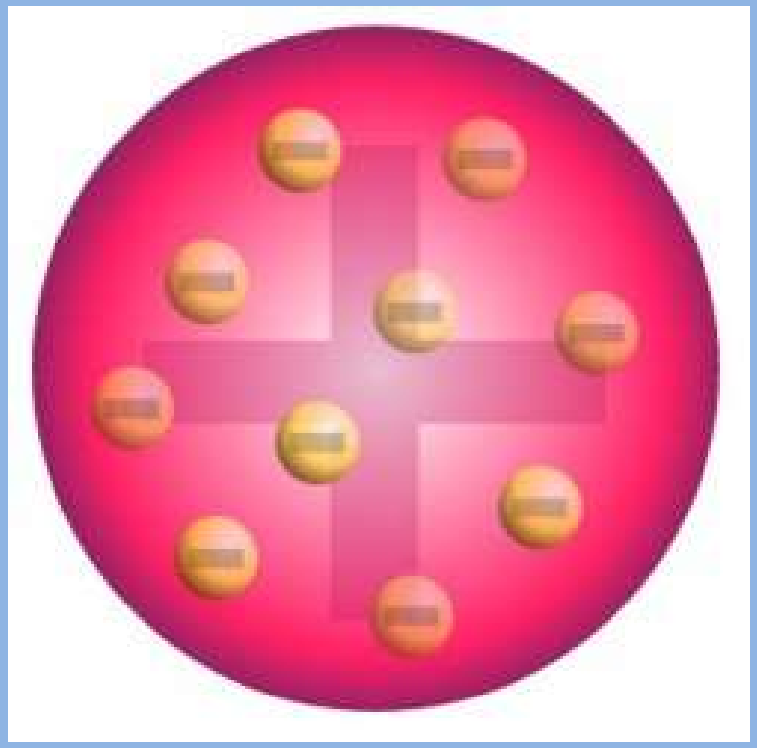


Thompsons atomic model could account for…..



- the atom having an internal structure
- Light given off by atoms
- Atom with different atomic masses

Thompsons atomic model could NOT account for…..



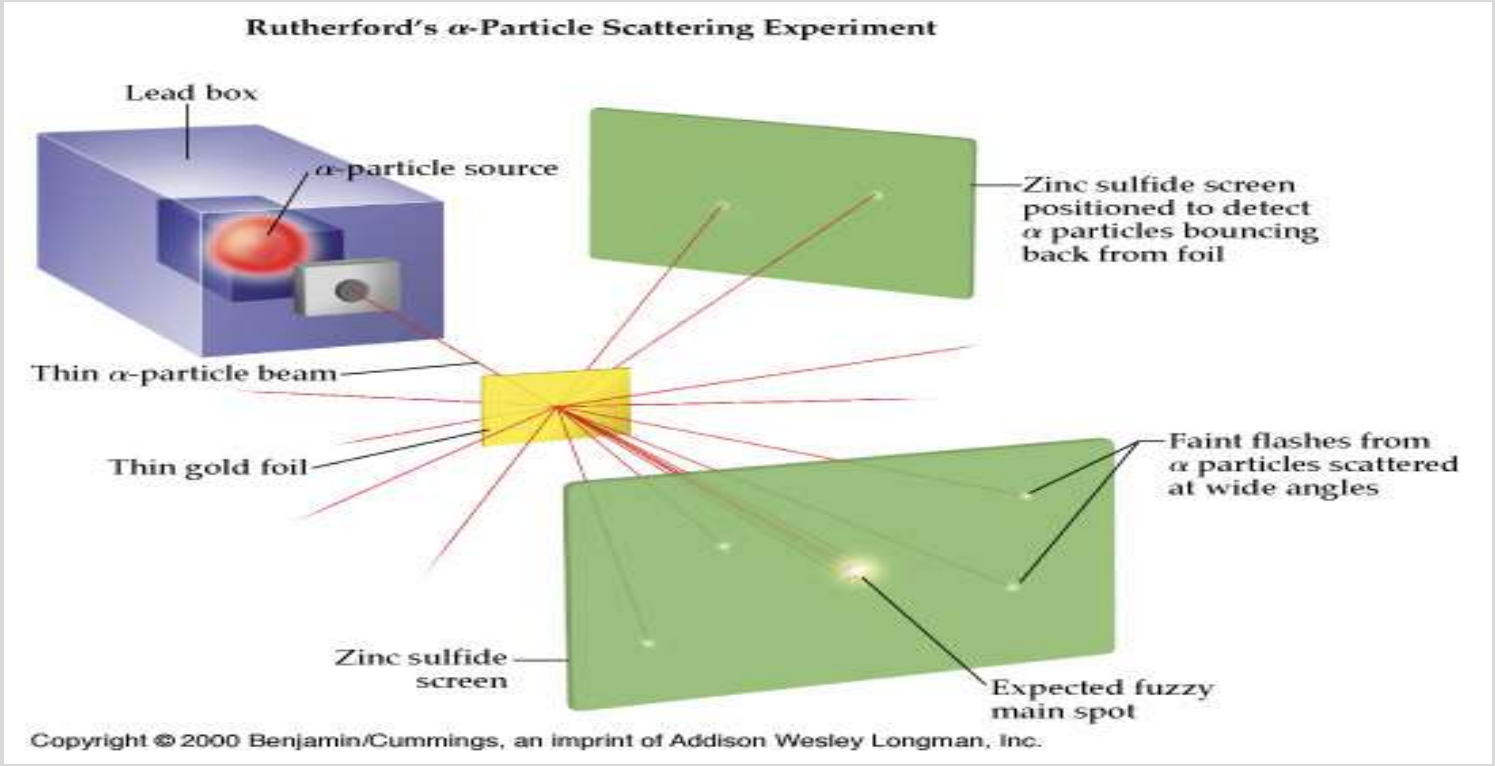
- Empty space (had atom filled with positive pudding)
- Formation of ions

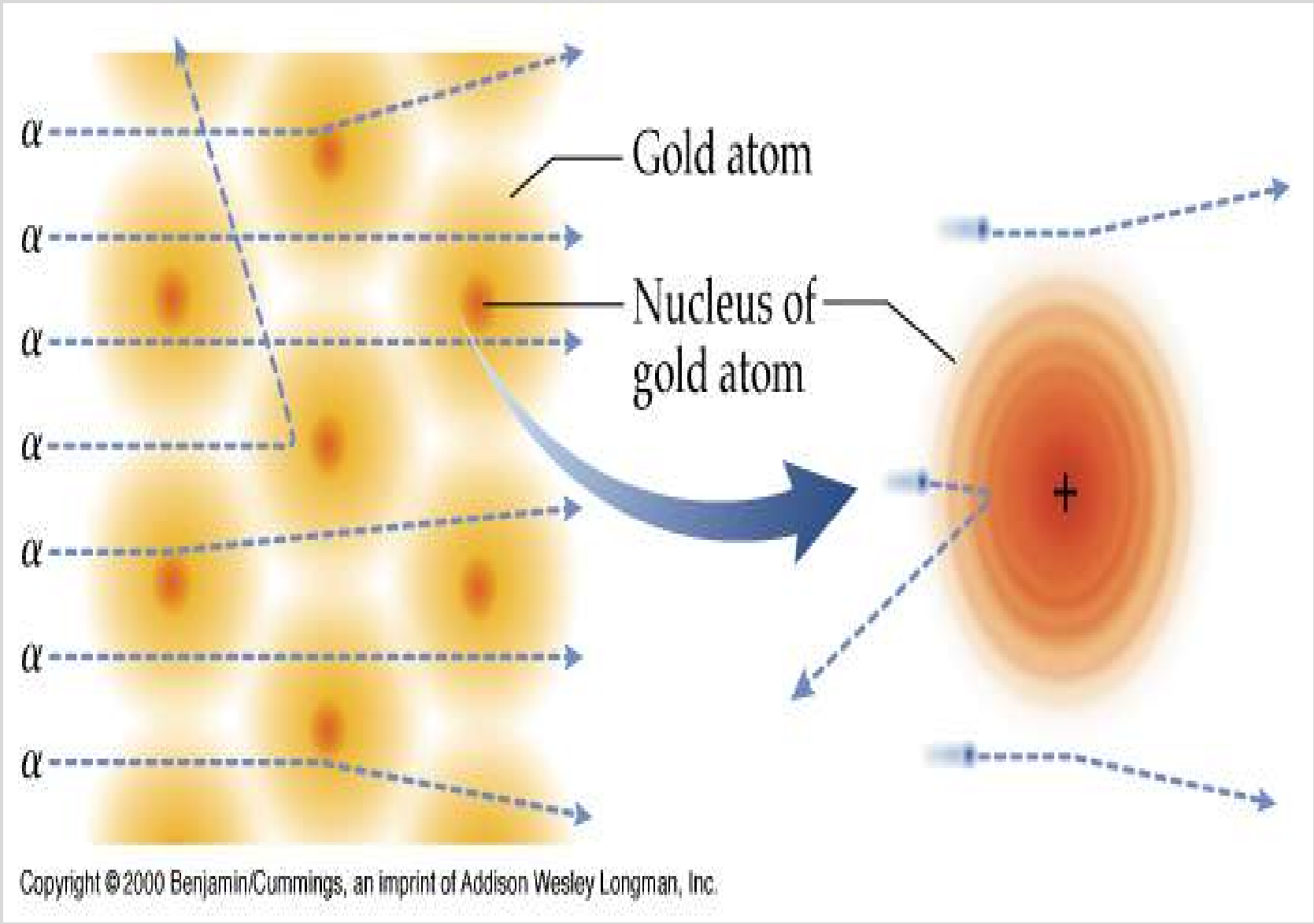
Gold Foil Experiment

- Conducted by students of Rutherford.
- Proved that all atoms had a tiny, positively charged center.
- Confirmed that atom's were mostly empty space.

Rutherford ~ early 1900s

- α-particle interaction with matter studied in gold foil experiment



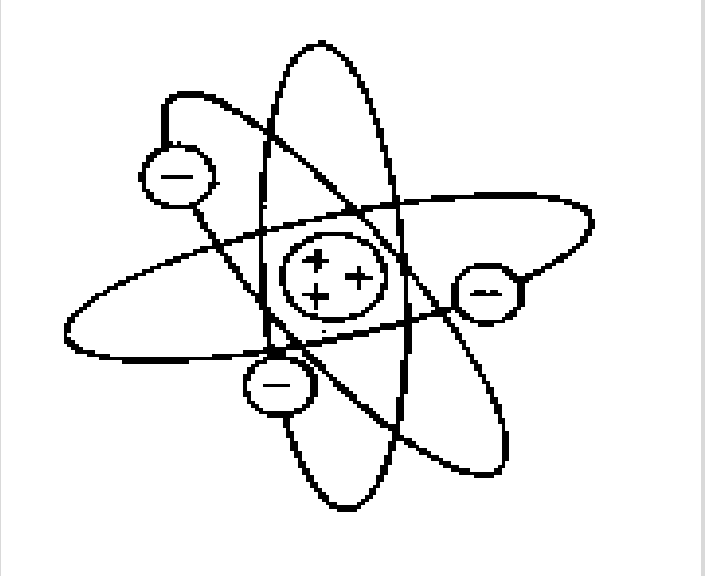


Rutherford's Nuclear Model

- **1. The atom contains a tiny dense center**
  - the volume is about 1/10 trillionth the volume of the atom
- **2. The nucleus is essentially the entire mass of the atom**
- **3. The nucleus is positively charged**
  - the amount of positive charge of the nucleus balances the negative charge of the electrons
- **4. The electrons move around in the empty space of the atom surrounding the nucleus**

Rutherford's atomic model (1911)

- Could account for:
  - Empty space
  - Ions
  - Internal structure
  - Light given off when heated to high temperature.



- Could not account for:
  - Stability

Bohr

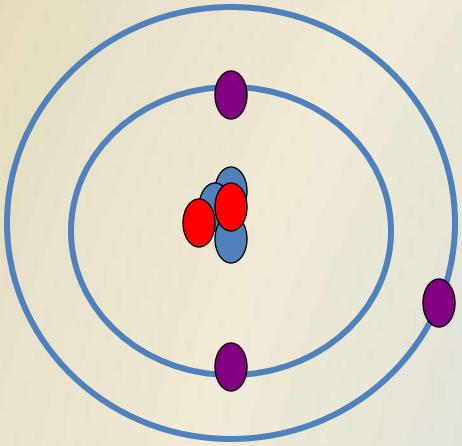
- Questioned 'planetary model' of atom
  - Electrons located in specific levels from nucleus (discontinuous model)
- Proposed electron cloud model based on evidence collected with H emission spectra

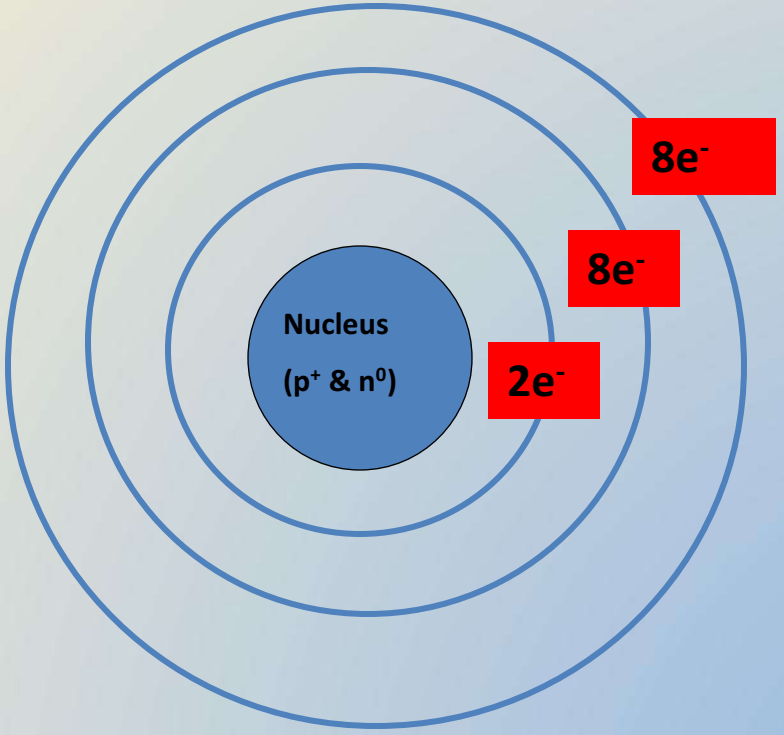
Bohr's Atomic Model (1913)

- Bohr was a student of Rutherford.
- Improved Rutherford's model by proposing electrons are found only in specific fixed orbits.
- These orbits have fixed levels of energy
- This explained how electrons could give off light (gain or lose energy)

BOHR MODEL

- Electrons are placed in energy levels surrounding the nucleus





Bohr's Atomic Model

- Could account for
  - Internal structure
  - Atoms of different masses
  - Atom being mostly empty space
  - Light given off
  - Formation of positive ions
- Flaws
  - Only really worked for Hydrogen

Chadwick (1932)

- Discovered the neutron by bombarding Be with beta radiation.

- Nuclear fission released a neutron.

Review

- Describe each of the 6 different atomic models. Give the
  - Scientist Name
  - Name of model
  - What they could account for
  - What they could not account for (flaws)

Subatomic particle summary

Particle	Discovery by	Year	experiment
Proton	Rutherford	1911	Gold Foil Experiment
Electron	Thompson	1887	The response of cathode ray tube to a magnetic and electric fields
Neutrons	Chadwich	1932	Bombarded Be with beta radiation and a neutron was released

Subatomic Particles

Name	Symbol	Charge	Relative mass	Actual mass (g)
Electron	e^-	-1	1/1840	9.11×10^{-28}
Proton	p^+	+1	1	1.67×10^{-24}
Neutron	n^0	0	1	1.67×10^{-24}

Subatomic Particles (cont.)

- All atoms of an element have the same # of protons

  protons identify an atom → atomic #

- Atoms are electrically neutral

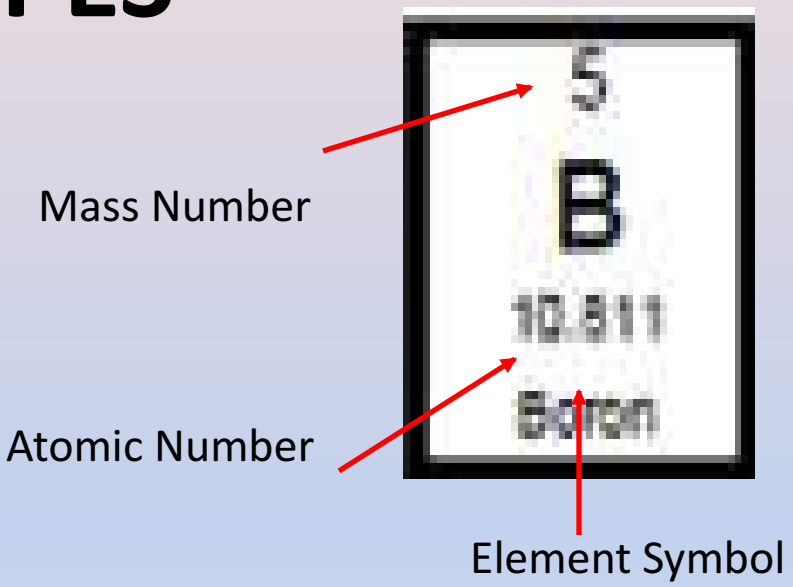
  $\#p = \#e^-$

- Only neutrons and protons contribute to an atoms mass

  #n + #p = atomic mass

ISOTOPES

- atoms with the same number of protons but DIFFERENT numbers of neutrons



Ex. Na-23 or Sodium-23

C-14 or Carbon-14

F-19 or