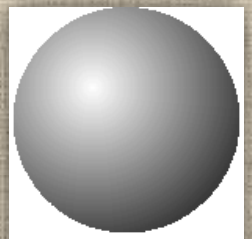
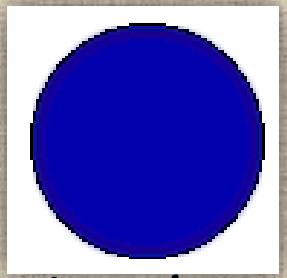
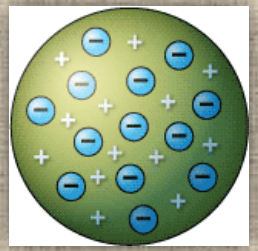
Evolution of the Atomic Model



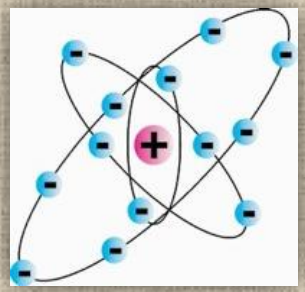
Democritus
(400 B.C.)



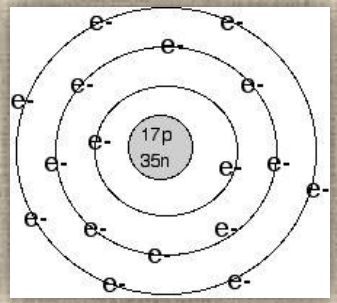
John Dalton
(1802)



J.J. Thomson
(1897)

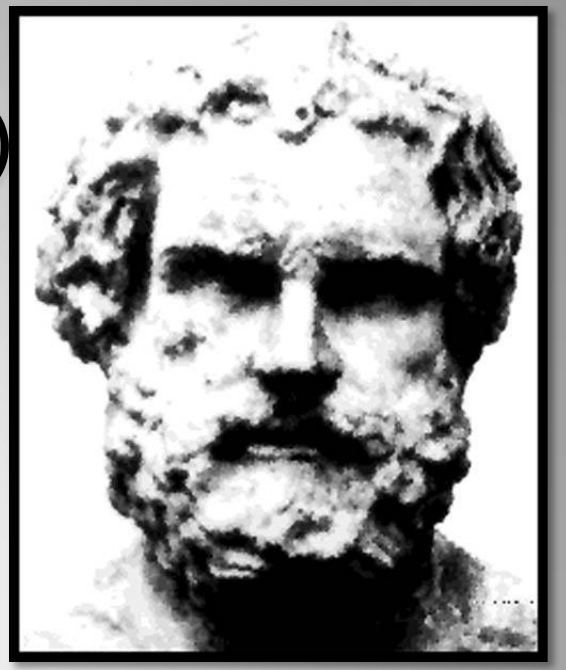


Ernest Rutherford
(1911)

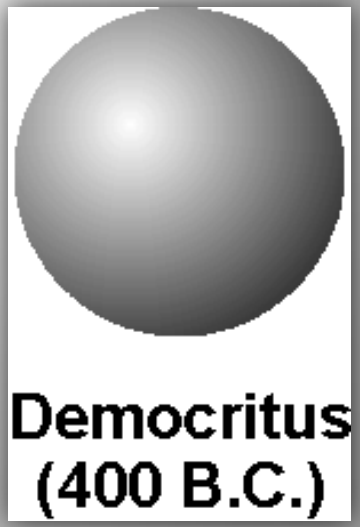


Niels Bohr
(1913)

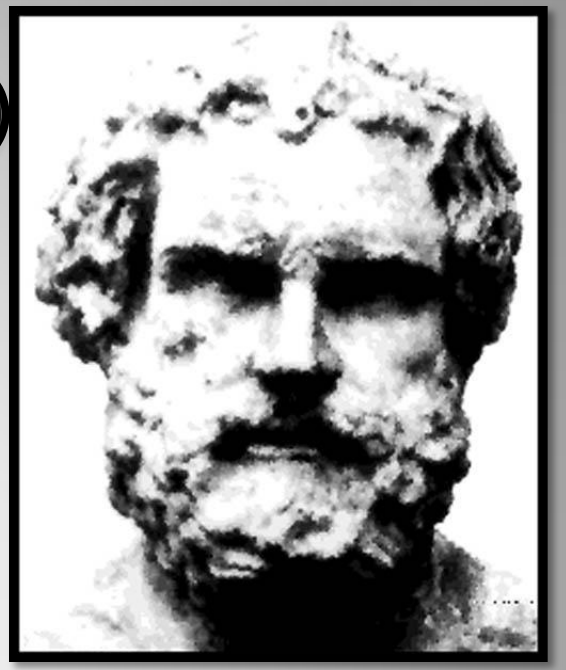
DEMOCRITUS (~440 BC)



- WHO WAS HE?
  - A Greek philosopher
- THEORIZED:
  - Everything in the world is made up small particles that we cannot see
  - The shape of these particles determine the properties of a substance

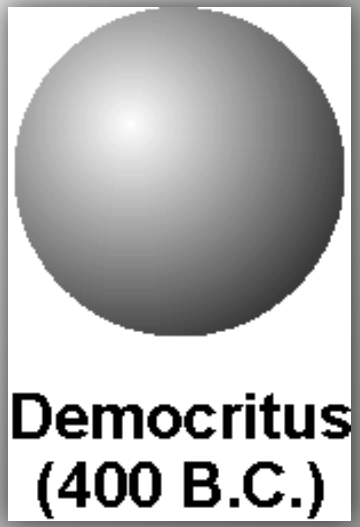


Democritus (~440 BC)



- "Discovery":
  - matter can be cut into smaller and smaller pieces that eventually cannot be broken down anymore
  - *These* are the building blocks of all matter!

- Model:
  - "**Atomos**" – Greek for uncuttable
  - The atom is a **small**, **solid sphere**

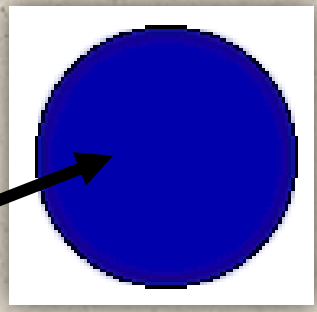


John Dalton (1766-1844)

- **Who was he?**
  - A British schoolteacher and meteorologist

- **Experiment:**
  - He studied the atmosphere and the behavior of gases, and decided that *all* forms of matter must be made up of small individual particles with different weights

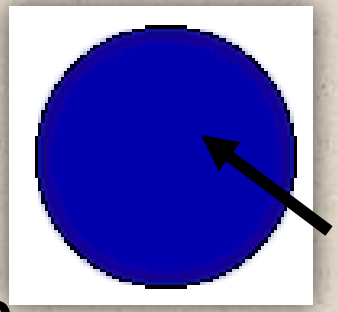
John Dalton's version of "The Atom"



John Dalton (1766-1844)

- **Discovery (1802): The Atomic Theory**
  - All matter is made up of atoms.
  - All atoms of an element are alike, but different from atoms of other elements.
  - Compounds form when atoms of different elements combine.
  - Chemical reactions involve rearranging atoms, not a change in the atom.

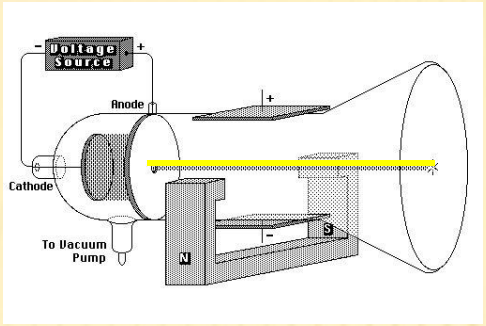
- **Model:**
  - The **"Billiard Ball Model":**
  - The atom is a **small**, **solid sphere**

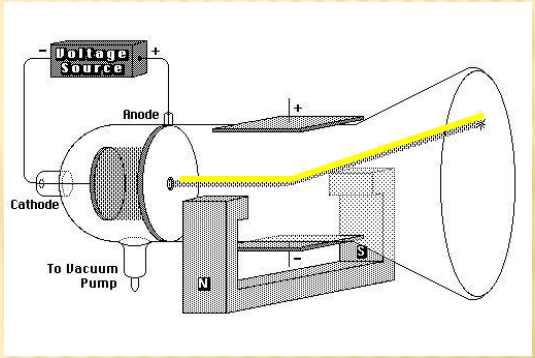


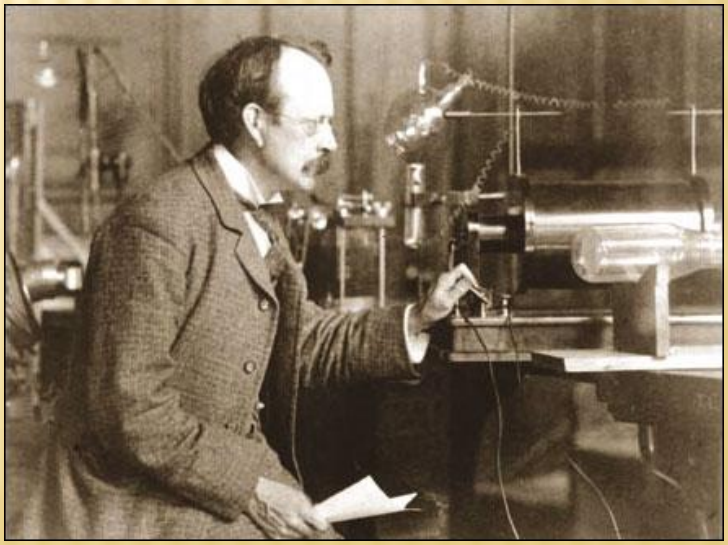
John Dalton's version of "The Atom"

J.J. THOMSON (1856–1940)

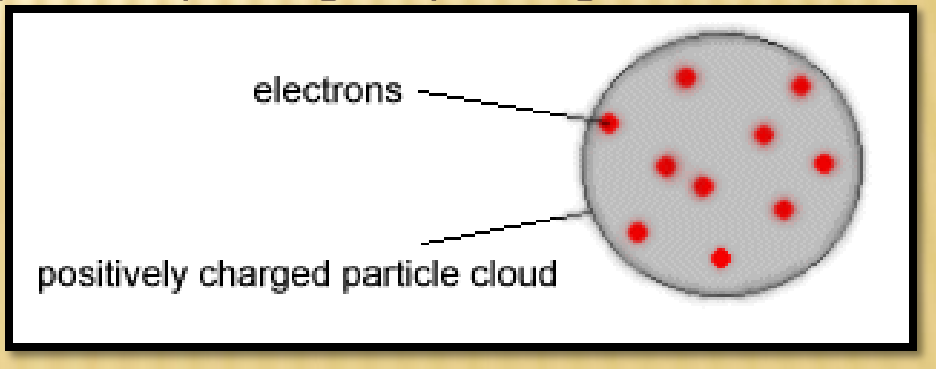
- **Who was he?**
  - A British scientist
- **Experiment:**
  - Passed an electric current through a vacuum tube
  - Observed the electric current
    - Discovered that mysterious glowing stream would bend *toward* a positively charged electric plate
    - Determined the electric current must be made up of small particles that carried a *negative* charge!



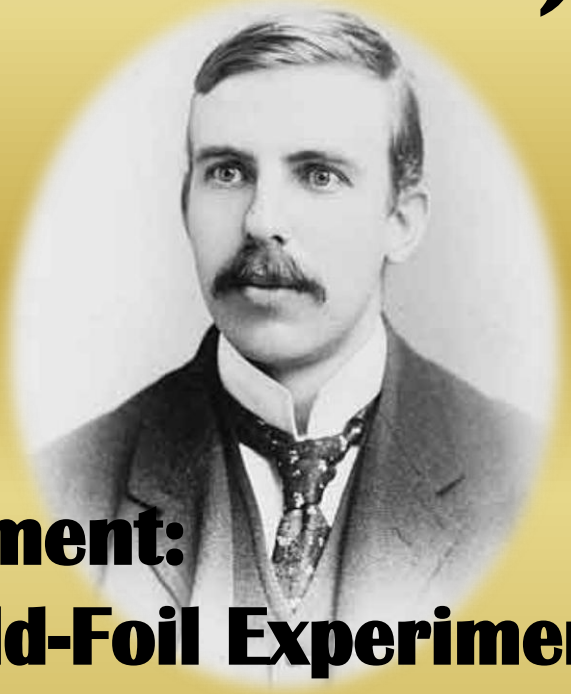




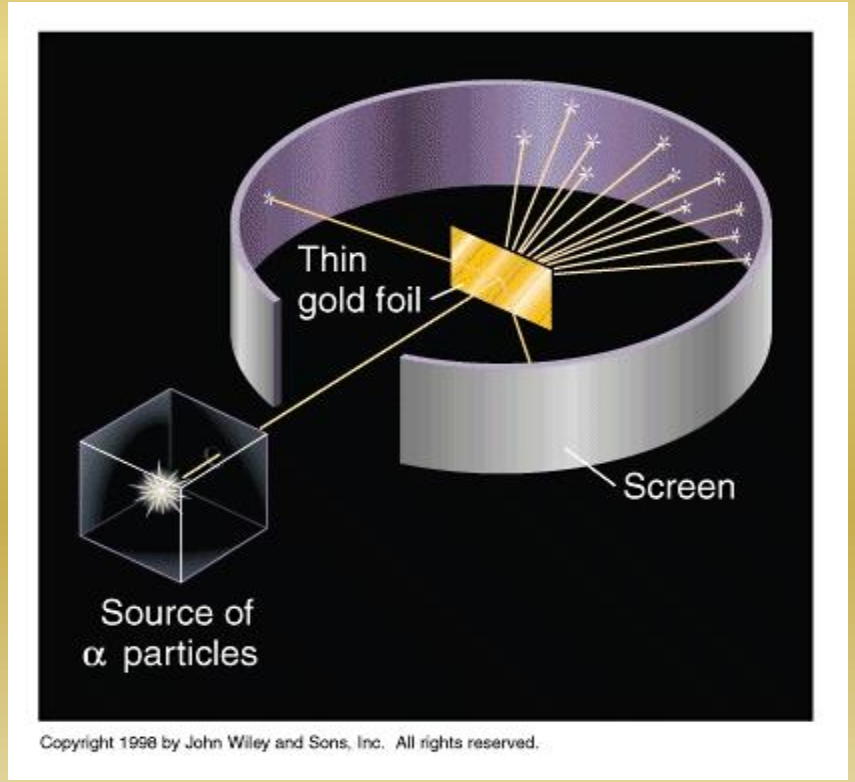
- **Discovery** (~1897):
  - The negatively charged particle called the **electron**
  - It takes 2000 electrons to equal the mass of one proton
- **Model:**
  - The "**Plum-Pudding Model**"
  - Each atom was like a sphere that was filled with a positively charged fluid
    - Negatively charged electrons, known as the "plums" were scattered throughout a positively charged "pudding"



Ernest Rutherford (1871-1937)



- **Who is he?**
  - A New Zealand physicist who pioneered modern atomic science

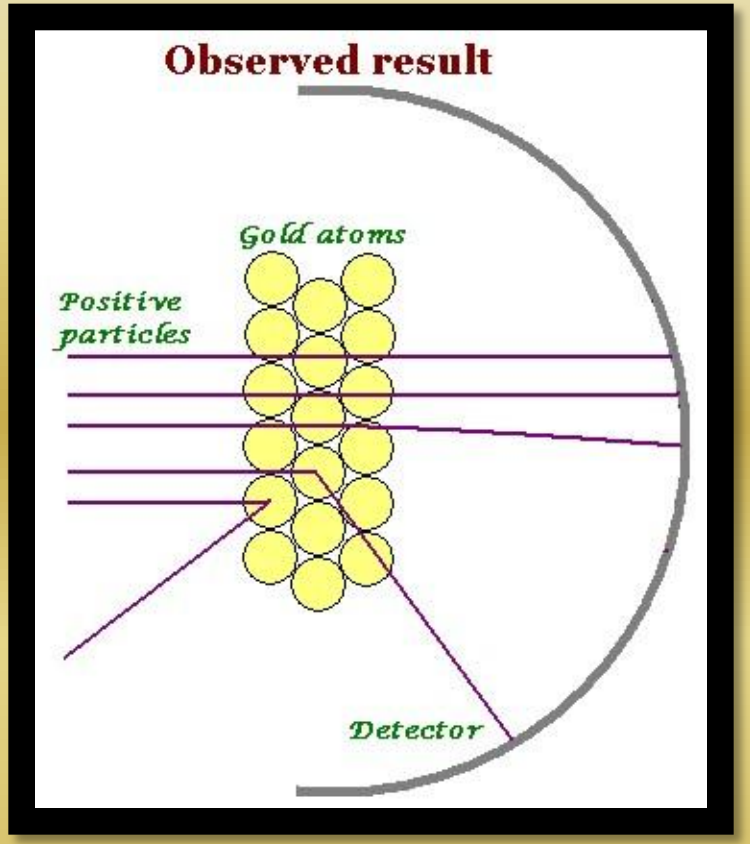


- **Experiment:**

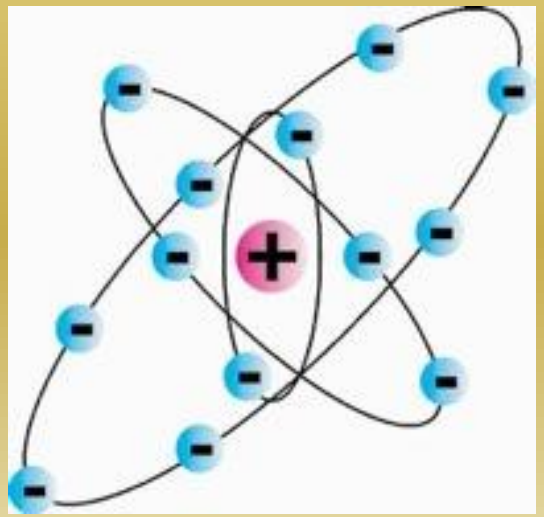
"The Gold-Foil Experiment"

  - Fired positively charged particles (called alpha particles) at a thin sheet of gold foil
  - Most particles went through, some bounced back, some were deflected

- **Discovery (1909-1911):**
  - Most of atom is empty space!
  - Positively charged **nucleus** exists at the center of the atom
  - The nucleus is small compared to the total size of the atom

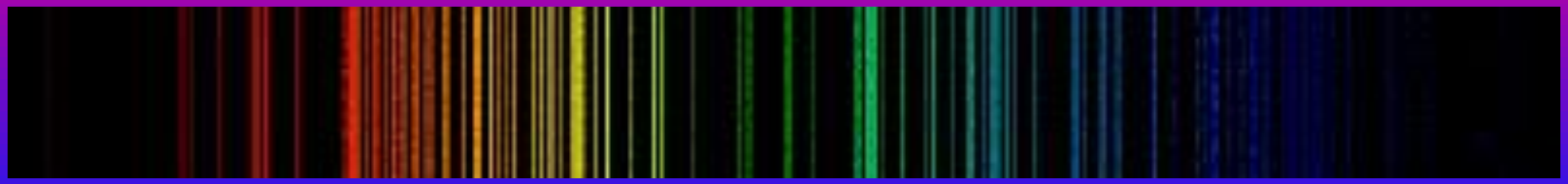


- **Model:**
  - The **"Planetary Model"**
  - Dense, positively charged nucleus surrounded by freely spinning electrons

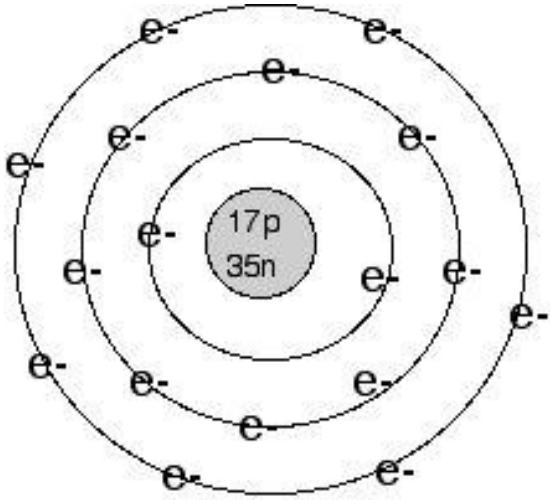


Niels Bohr (1885-1962)

- Who is he?
  - A Danish physicist
- Experiment:
  - Tried to explain why electrons could orbit the nucleus without getting pulled into it
  - Suggested the electrons **orbit nucleus in fixed energy levels** (or shells)
  - Electrons could jump between levels, giving off light we can see



- **Discovery (1913):**
  - The atom is much smaller than we thought!
  - That electrons exist in distinct orbits (**orbitals**) around the nucleus
  - Electrons absorb or give off energy when they move from one shell to another
- **Model:**
  - The **"Bohr Model"**
  - An electron's energy levels (*also called electron shells*) can be imagined as concentric circles around the nucleus



Erwin Schrödinger & Louis de Broglie

(1920's through Present)

Who were they?

- Louis de Broglie was a French scientist
- Erwin Schrodinger was a Austrian physicist

Experiment/Observation:

- Studied the movement of the electron around the nucleus to try and figure out why it didn't fall into the nucleus
- Schrodinger created a mathematical formula supporting de Broglie's

Discovery (~1925):

- **Electrons travel in clouds** around the nucleus
  - It is **impossible** to **know** the **speed and** exact **location** of an electron
  - It is only possible to **calculate** the **probability of finding** an **electron** within a given space
- Electrons can **behave like waves or particles**

Model:

- The **"Electron Cloud Model"** (Also known as the "**Quantum Mechanical Model**")
- There are no defined orbitals like Bohr thought, just areas where electrons *might* be