Models of the Atom

**Aim:** To discuss the scientists and their contributions to the current atomic model.

### Oldest
- Dalton
- Thompson
- Rutherford
- Bohr

### Current
- Modern Model ("Wave-Mechanical" Model)

### Parts of an Atom

1) **Nucleus** – center of the atom containing protons and neutrons.

2) **Principle Energy Levels** - orbits or shells that hold the electrons outside of the nucleus.
Democritus- 460 B.C.

- Democritus was a greek philosopher who developed the first atomic theory.
- States that matter is made up of very small, internal, indivisible parts, called atoms.
- He believed that atoms only differed in shape and size but were all identical. He thought everything was the same element.

\textbf{What was incorrect about Democritus' model? What was missing?}

\textit{His model was missing subatomic particles and a nucleus. Not all elements are identical.}

Dalton's Atomic Theory

1) All elements are composed of atoms
2) All atoms of a given element are identical
3) Atoms of the same element have the same mass
4) Compounds consist of two or more elements combined in a fixed proportion.
   Ex: Water (H$_2$O) is ALWAYS 2 atoms of hydrogen bonded to 1 atom of oxygen.
5) Chemical reactions occur when atoms are rearranged
John Dalton's Model - Early 1800's

The atom was a dense, hard, indivisible sphere with no subatomic particles.

When Dalton developed his model no one knew subatomic particles existed.

• How was Dalton's atomic model incorrect?
• What was missing?

His model was missing subatomic particles and a nucleus.

A beam of particles was fired through two charged plates. The beam attracted towards the positive charge. Therefore Thomson concluded all atoms have a negatively charged particle.

Cathode Ray Tube Experiment
**J.J Thompson's Plum Pudding Model - 1897**

**Plum Pudding Model** - the atom is a sphere of positive charge with electrons embedded throughout. (like a chocolate chip cookie)

Discovered the electron through experiments with a cathode ray tube.

Proved the electron to be a part of every atom.

- **How was Thomson's atomic model incorrect?**
- **What was missing?**

  *His model was missing a nucleus, protons and neutrons.*

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**Rutherford's Gold Foil Experiment**

This experiment led to the most substantial discovery of the atom:

- A piece of gold foil was bombarded with alpha particles which have a positive charge.

- ALL OF THE particles should have passed straight through the foil based on the Thomson's model of the atom but they DIDN'T!

**OBSERVATIONS:**
- Most alpha particles passed straight through
- A small amount of alpha particles bounced backwards or deflected to the side at an angle.

**CONCLUSION:** The atom has a **small, dense positive nucleus and is composed of mostly empty space.**
The atom is mostly empty space.

Determined by the fact that most alpha particles passed straight through the foil undeflected.

The nucleus is small, dense, and has a positive charge.

Determined by the fact that only a small amount of alpha particles were deflected when they came close to the positive nucleus.

Rutherford's Gold Foil Experiment - Summaries

Rutherford conducted the Gold Foil Experiment.

From this experiment he discovered two properties of the atom:
1) It had a small, positive, dense, nucleus
2) It was mostly empty space.

Nuclear model: Central positive nucleus surrounded by empty space and electrons scattered around it.

• How was Rutherford's atomic model incorrect?
• What was missing?

His model was missing a location for the electrons (PEL and orbitals)
Bohr Model of the Atom - 1913

**Planetary model**: Electrons orbit the nucleus like planets around the sun.

Bohr placed the electrons in energy levels (shells) outside of the nucleus.

The electrons travel in a fixed path or orbit around the nucleus.

- How was Bohr's atomic model incorrect?
- What was missing?

His model was missing the orbitals for the electrons and had electrons in shells.

Wave Mechanical Model

**THIS IS THE MODEL ACCEPTED TODAY.**

**Wave Mechanical Model**: Electrons surround the nucleus in their principle energy levels but are further divided into sublevels and sit in orbitals.

An orbital is the most probable location of finding an electron.

The electrons constantly move.

The electrons form an "electron cloud" because all of the movement gives the appearance of a cloud.