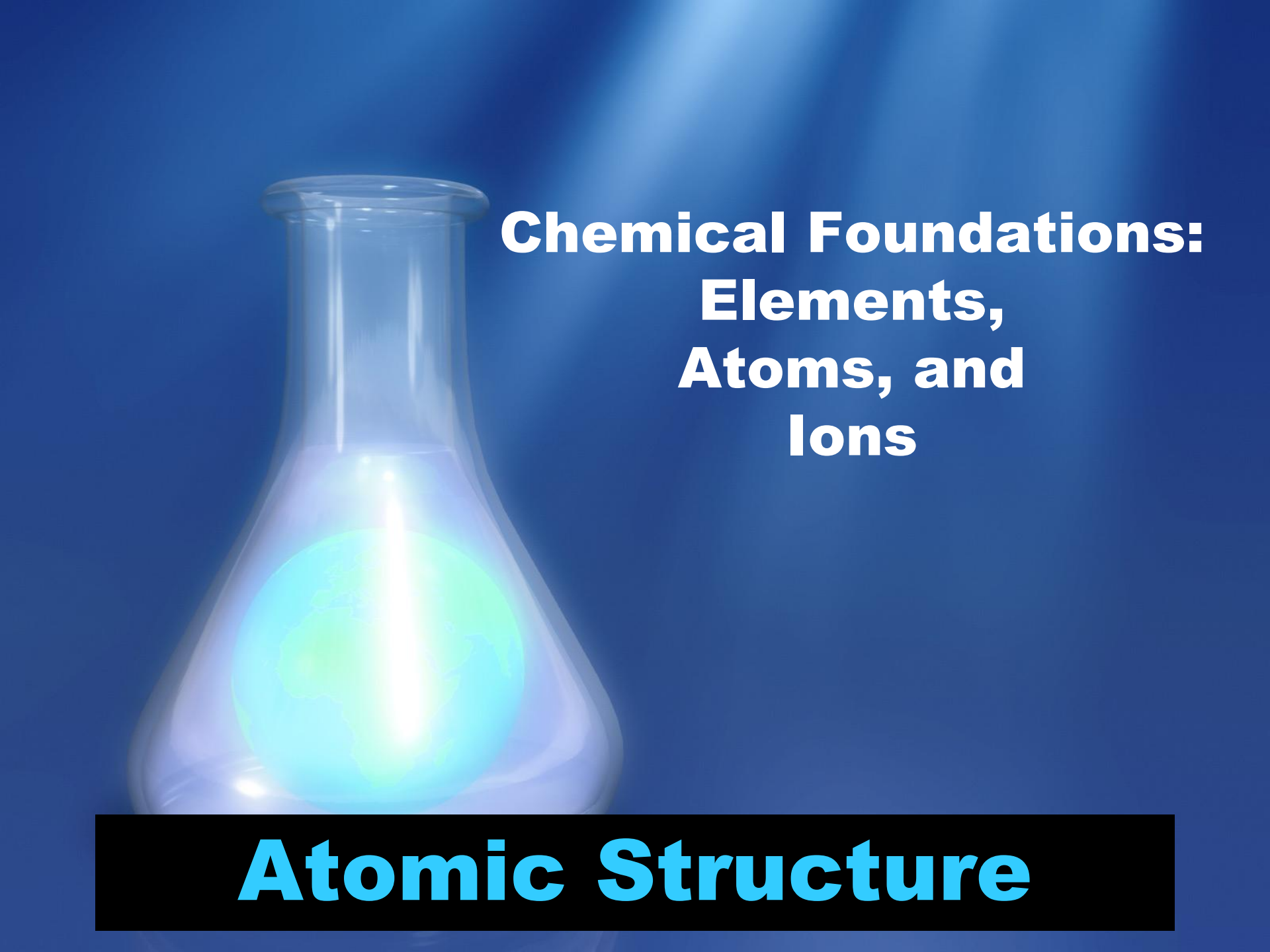
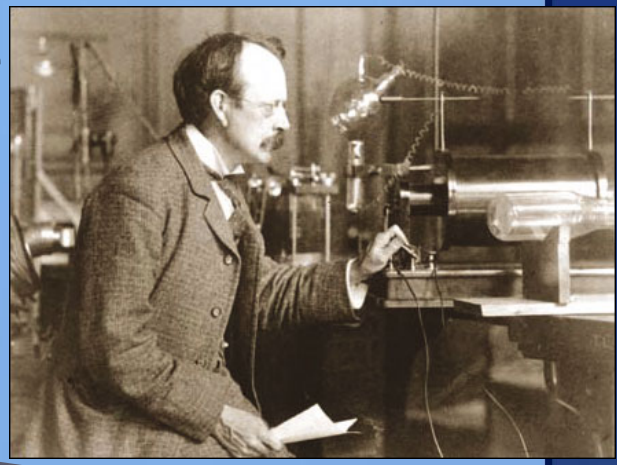
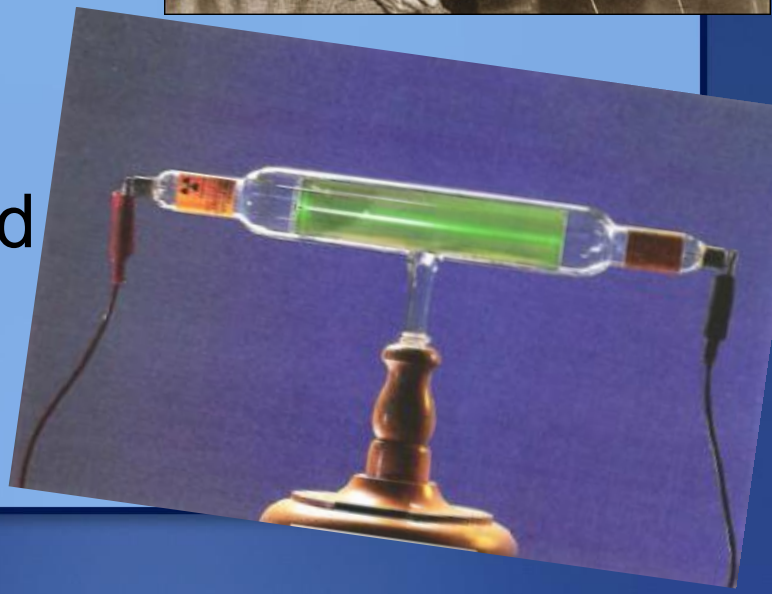

Chemical Foundations:
Elements,
Atoms, and
Ions
Atomic Structure

The Structure of the Atom

Thomson's Experiment

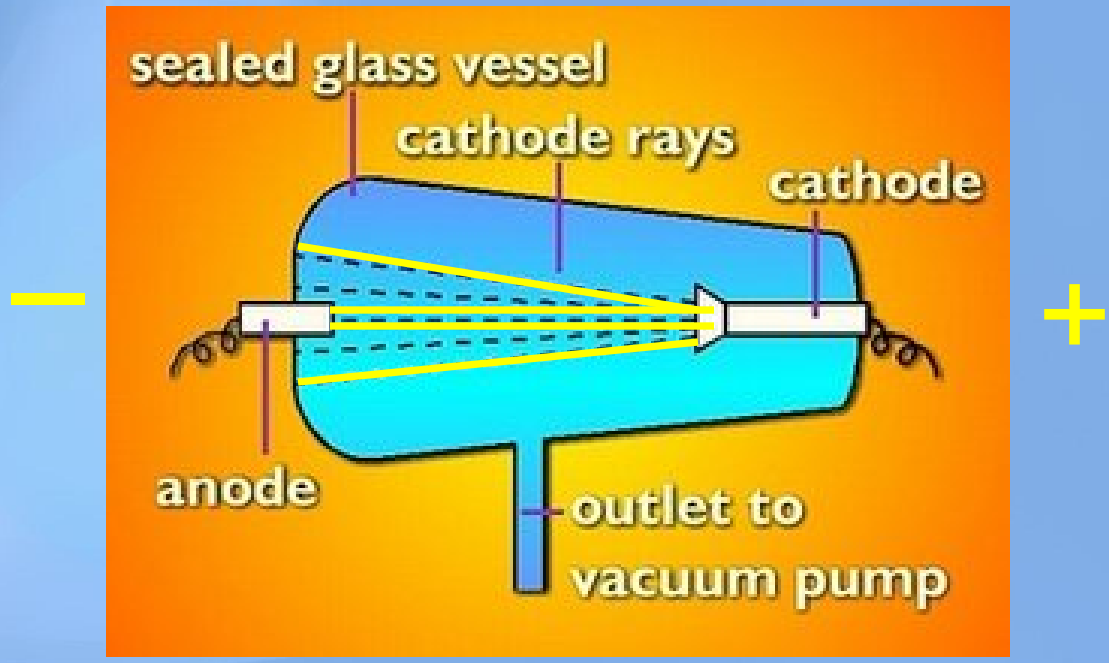
- J.J. Thomson used a cathode ray tube to show that the atoms of any element can be made to emit tiny negative particles.
  - Particles were negative because they were repelled by the negative end.



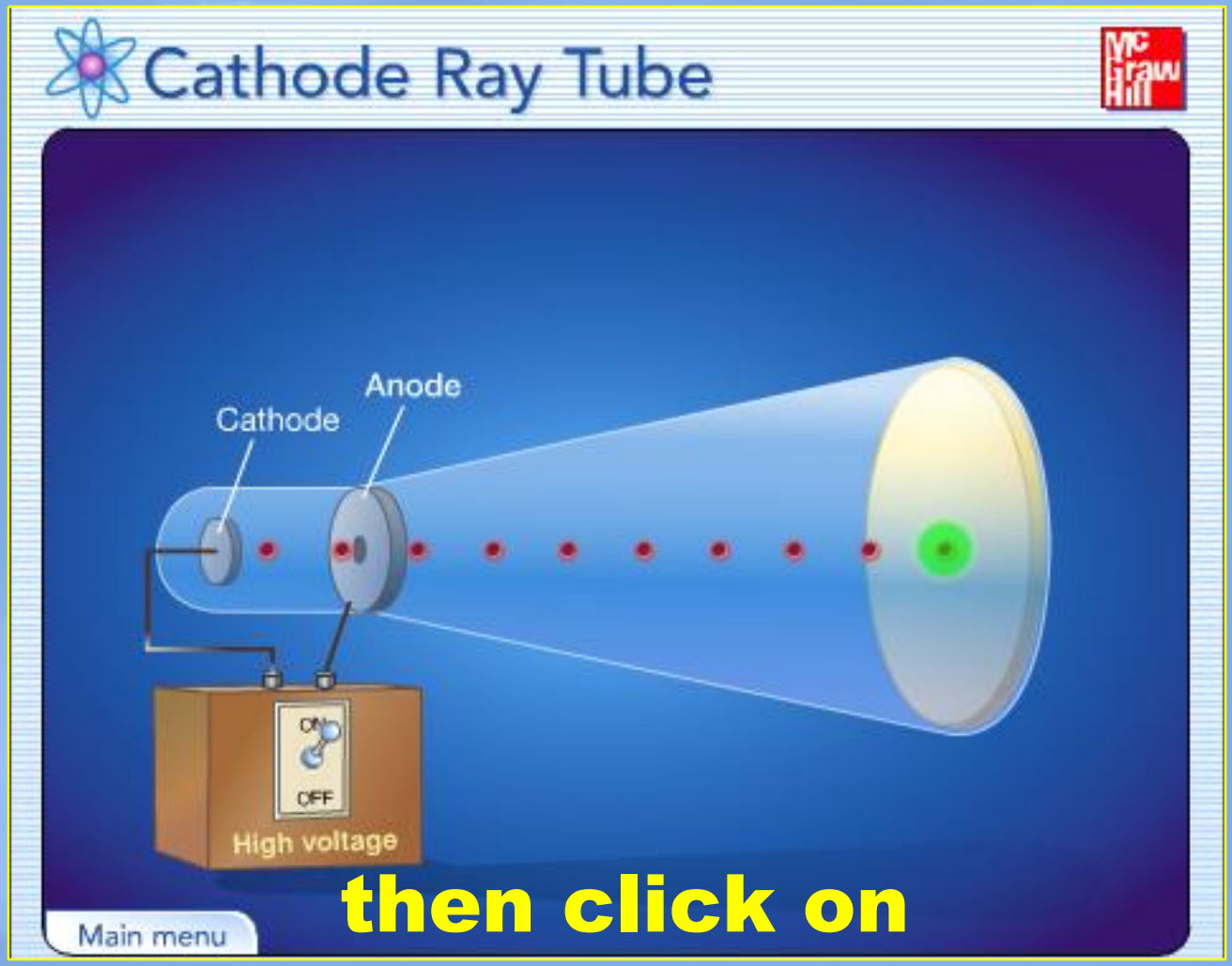


The Structure of the Atom

- **Electron** → a negatively charged subatomic particle.
- Concluded that atoms must contain positive particles to balance the electrons.



Click the image below to learn more about Cathode Ray Tubes



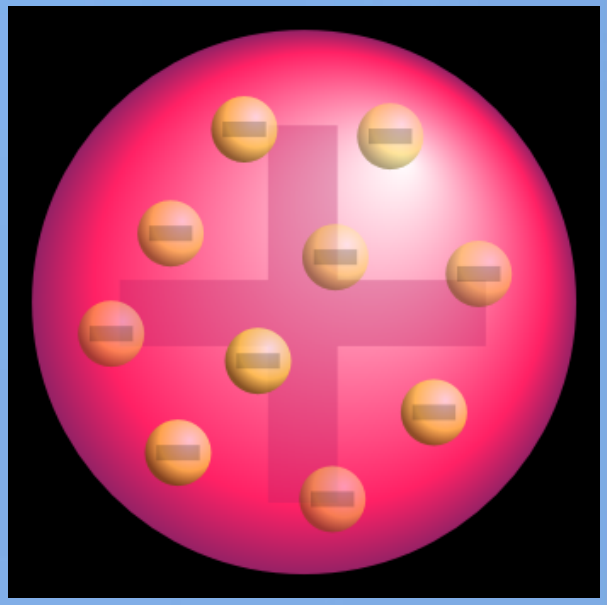
then click on

"Cathode Ray Tube (805.0K)"

The Structure of the Atom

The Plum Pudding Model

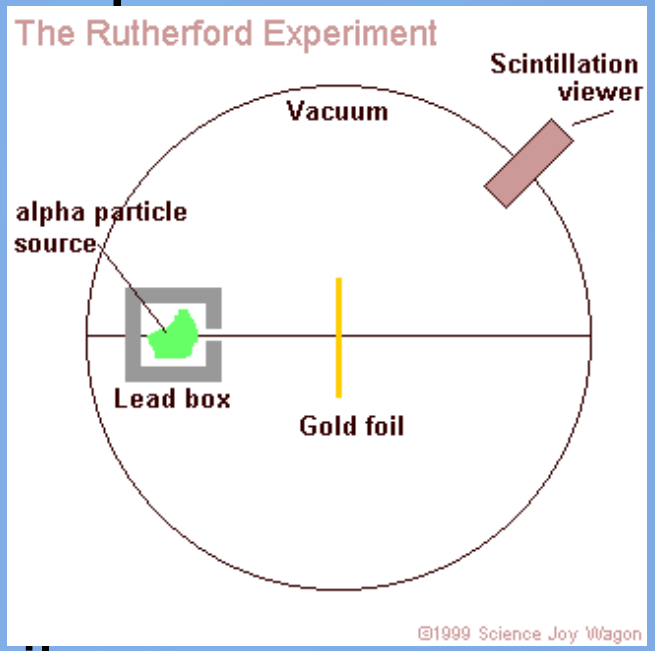
- J.J Thomson and William Thomson (Lord Kelvin) proposed that an atom was like plum pudding -- a pudding with raisins randomly distributed throughout.
  - The atoms was a uniform "pudding" of positive charge with enough negative electrons scattered about to balance the positive charge.



The Structure of the Atom

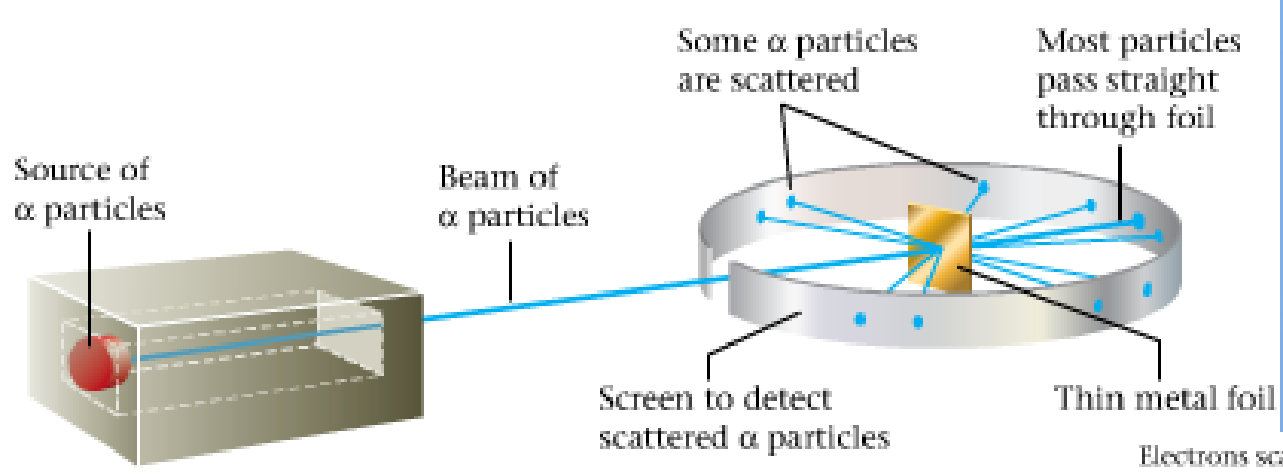
Rutherford's Experiment

- Ernest Rutherford designed an experiment that involved directing alpha particles (αparticles), toward thin metal foil.
  - α particles are positively charged.
  - A detector coated with a substance that produced tiny flashes when hit by an α particle surrounded the foil.

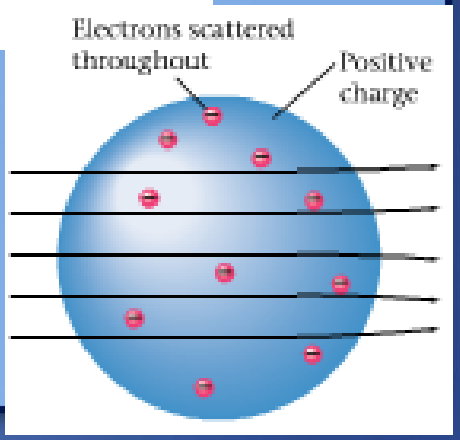


The Structure of the Atom

– Most of the α particles passed straight through the foil, some of them were deflected at large angles, and some were reflected backward.

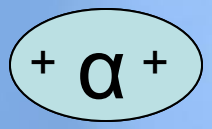


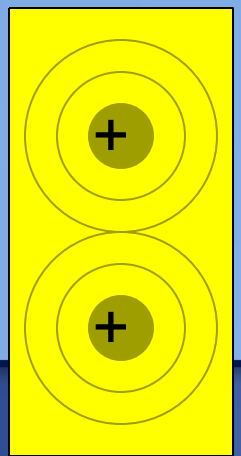
– If the plum pudding model were correct, the α particles would have passed right through the foil.



The Structure of the Atom

- Concluded that the plum pudding model for the atom could not be correct!
  - Since most of the α particles passed directly through because the atom is mostly open space.
  - The large deflections were caused when the positively charged α particles were repelled by a center of concentrated positive charge.

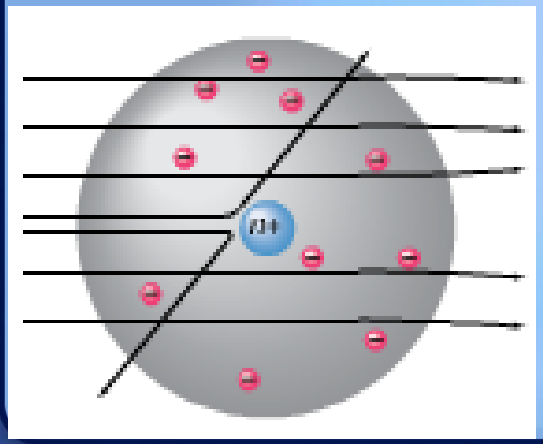




The Structure of the Atom

The Nuclear Atom

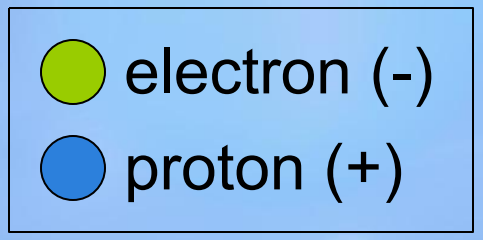
- **Nuclear atom** → a modern concept of the atom having a dense center of positive charge (the nucleus) surrounded by moving electrons.
- **Nucleus** → the relatively small, dense center of positive charge in an atom.
- Rutherford concluded that the nucleus had to

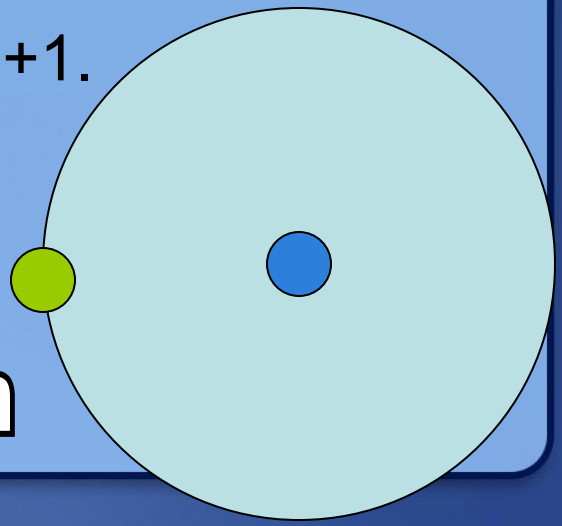


- have a positive charge to balance the negative charge of the electrons.
- be small and dense.

The Structure of the Atom

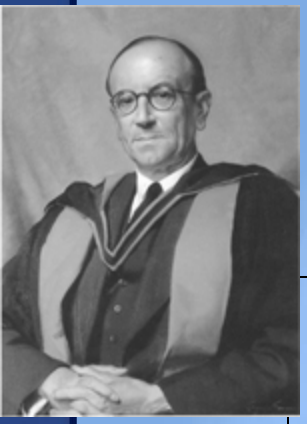
- By 1919, Rutherford concluded that the nucleus of an atom contains protons.
  - **Proton** → a positively charged subatomic particle located in the atomic nucleus.
    - Has the same magnitude (size) of an electron.
    - Electrons have a charge of -1.
    - Protons have a charge of +1.





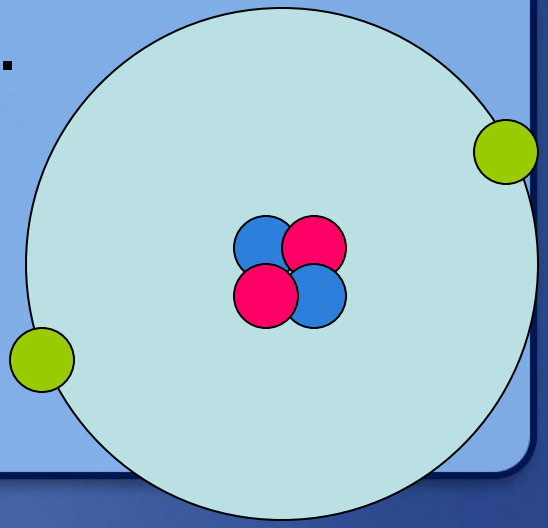
The Structure of the Atom

- In 1932, Rutherford and James Chadwick showed that most nuclei also contain a neutral particle called the neutron.
  - **Neutron** → a subatomic particle with no charge located in the atomic nucleus.
    - Slightly more massive than a proton.
    - Neutrons have no charge.



electron (-)
proton (+)
neutron (0)

helium

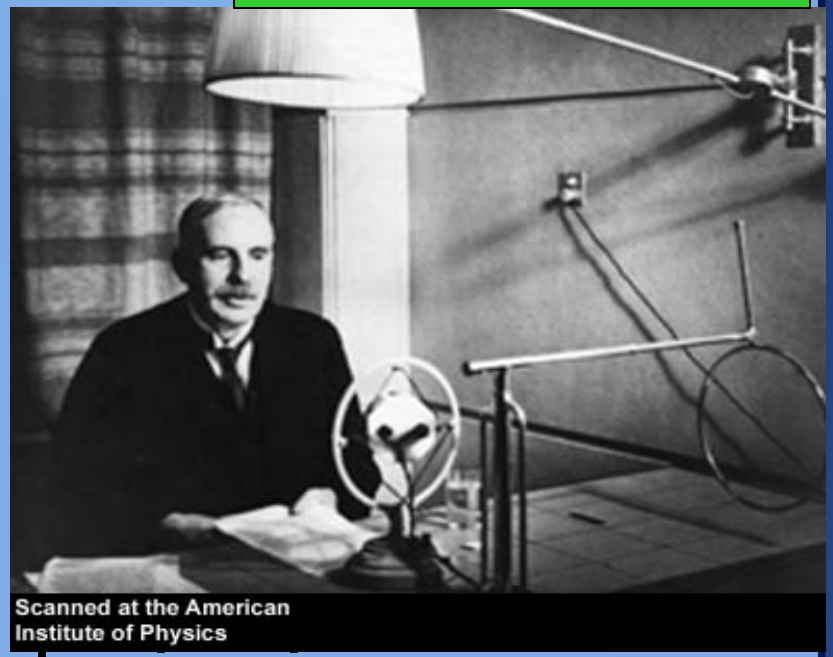


The Structure of the Atom

Chemistry Explorers: Ernest Rutherford

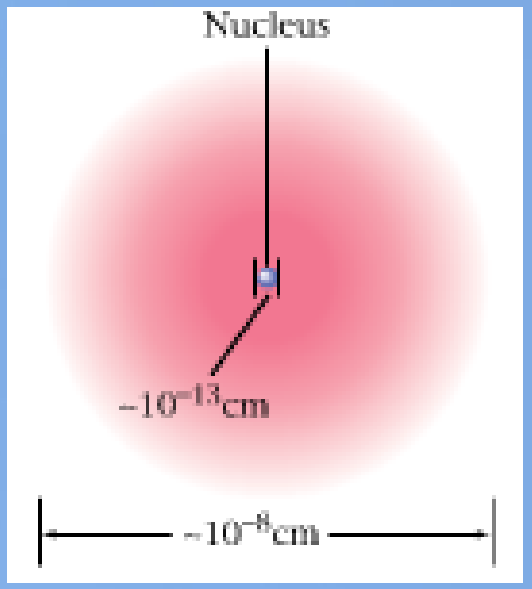
- 1871 - 1937

- Born in New Zealand.
- Won a scholarship to Cambridge University in 1895.
- A master at designing the right experiment to test a given idea.
- Was awarded the Nobel prize in chemistry in 1908.



Introduction to the Modern Concept of Atomic Structure

- The simplest view of the atom is that it consists of a tiny nucleus (about 10^{-13} cm in diameter) and electrons that move about the nucleus at an average distance of about 10^{-8} cm from it.
  - The nucleus is actually much smaller than the atom itself.



Introduction to the Modern Concept of Atomic Structure

- Nucleus:
  - Protons - positive charge and mass equal to that of a neutron.
  - Neutrons - function not obvious, but may help hold the protons together.
- Electrons - negative charge and very small mass.

Table 3.4

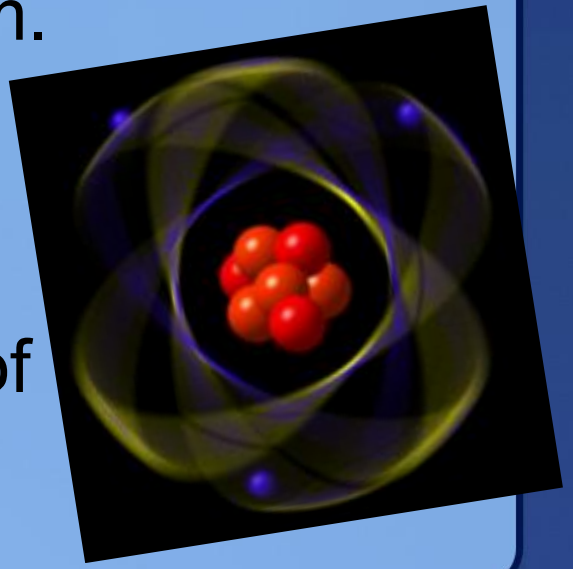
The Mass and Charge of the Electron, Proton, and Neutron

Particle	Relative Mass*	Relative Charge
electron	1	1−
proton	1836	1+
neutron	1839	none

*The electron is arbitrarily assigned a mass of 1 for comparison.

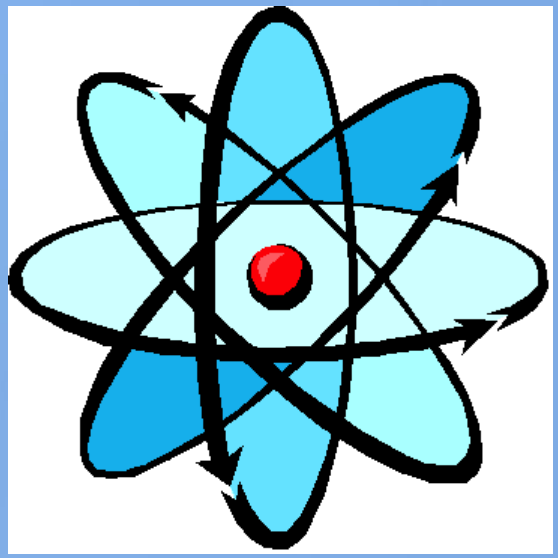
Introduction to the Modern Concept of Atomic Structure

- **Why do different atoms have different chemical properties?**
  - The number and arrangement of the electrons.
    - The space in which they move accounts for most of the volume of an atom.
    - The parts that "intermingle" when atoms combine to form molecules.
  - Atoms also vary in the number of protons, but they do not determine chemical behavior.



Introduction to the Modern Concept of Atomic Structure

- The number of electrons in an atom greatly affects the way it can interact with other atoms.
- Atoms of different elements:
  - Have difference numbers of electrons.
  - Show different chemical behavior.



The End