#### 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.



- 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



# 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.



– Most of the  $\alpha$  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  $\alpha$  particles would have passed right through the foil.



- Concluded that the plum pudding model for the atom could not be correct!
- Since most of the  $\alpha$  particles passed directly through because the atom is mostly open space.
  - The large deflections were caused when the positively charged  $\alpha$  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.

- By 1919, Rutherford concluded that the nucleus of an atom contained 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.

electron (-)proton (+)

- 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.

helium

Neutrons have no charge.

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

#### Chemistry Explorers: Ernest Rutherford

- Born in New Zealand.
- Won a scholarship to Cambridge University in 1895.
- A master at designing the right experiment to test a given idea.



1871 - 1937

Scanned at the American Institute of Physics

 Was awarded the Nobel prize in chemistry in 1908.

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



#### Nucleus:

- Protons positive charge and mass equal to that of a neutron.
- Neutrons function not obvious, but may help hold the protons Table 3.4 together. The Mass and Charge of the Electron,
- Electrons negative charge and very small mass.

Proton, and Neutron

Particle	<b>Relative Mass*</b>	<b>Relative Charge</b>
electron	1	1-
proton	1836	1+
neutron	1839	none
*The electron is arbitrarily assigned a mass of 1 for comparison.		

- 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 protons, but they do not determine chemical behavior.

- 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

