

# **The structure of the Atom**

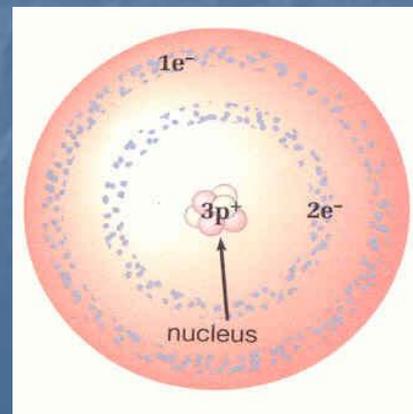
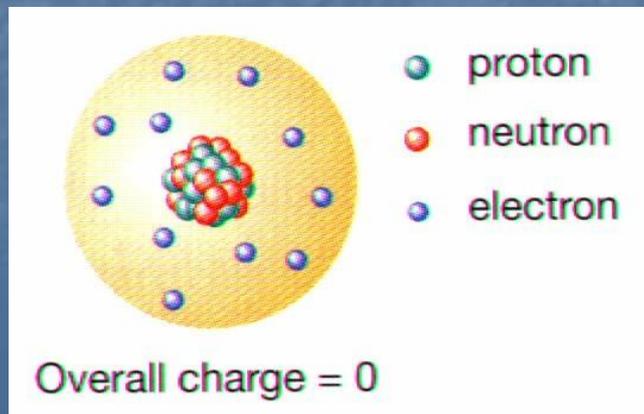
## **Chemistry chapter 4**

# Rutherford-Bohr Model

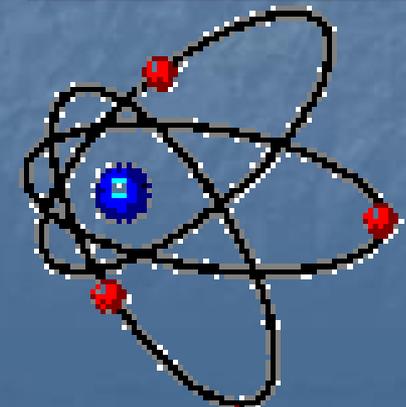


Niels Bohr (1922)

- Proposed improvements to Rutherford Atomic Model. For this reason the planetary model of the atoms is sometimes called the Rutherford-Bohr model
- Bohr added the idea of fixed orbits, or **energy levels** for the electrons traveling around the nucleus
- His atomic model has atoms built up of **successive orbital shells** of electrons
- Bohr Model or Orbital Model

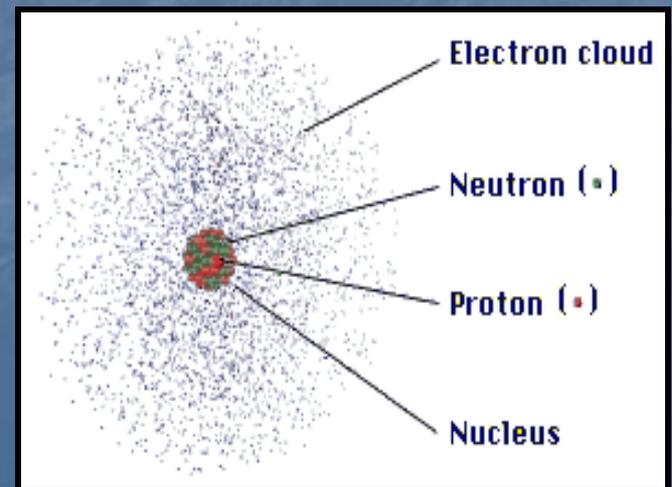
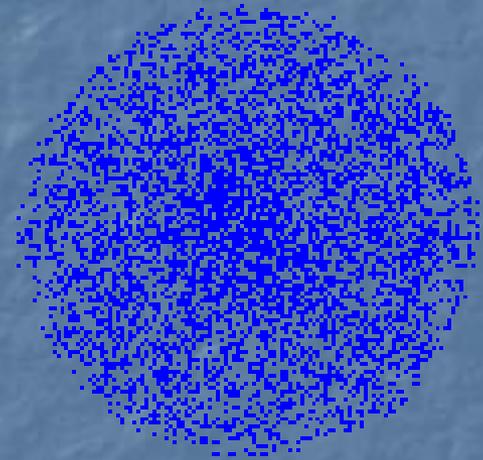


**Concepts In Motion**  
Click here to view an animated version of this graphic.

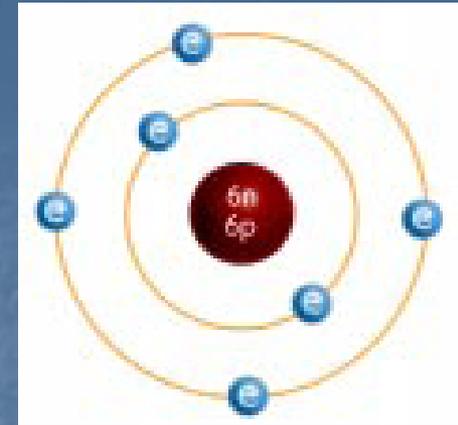


# Electron-Cloud Model

- The charge-cloud model, also called the **quantum-mechanical**, does not attempt to describe the path of each electron in a fixed point.
- Computers can calculate the points in space that an electron has the highest probability of occupying.
- Scientists have determined that protons and neutrons are composed of subatomic particles called quarks.



# Chemistry Vocabulary



**Atoms** – Basic building block of matter

- smallest unit of an element that retains properties of that element

Atom consists of 3 particles

- **Protons:** positive charge (+)
- **Neutrons:** neutral charge
- **Electrons:** negative charge (-)

Atom divided into 2 parts

- 1) **Nucleus** – center of atom, contains protons and neutrons
  - nucleus has positive charge

- 2) **Electron cloud** – region around nucleus that contains electrons

- probable location where electrons will be located
- this outer region is much larger than nucleus
- diameter of nucleus = 1/100,000 of electron cloud

Electron cloud has several layers – like an onion

- Electrons near the nucleus have low energy
- Electrons further away have higher energy

# Chemistry Vocabulary

- Each element is identified by a symbol and **Atomic Number**
- Atomic number
  - Atomic number is unique for each element
  - # of **protons** in nucleus = atomic number
    - number of protons for an element **NEVER** changes
  - # of **electrons** = atomic number
    - As long as atom is neutral
- Each element has a **mass number**
  - sum of the number of protons and neutrons in an atom
  - Periodic table lists the *Average mass number*
    - Mass number = # protons + # neutrons

The diagram shows a white rectangular box containing the following text from top to bottom: **8**, **O**, **Oxygen**, and **15.99**. Four green arrows point from external labels to these values: 'Symbol' points to 'O', 'Name' points to 'Oxygen', 'Atomic Number' points to '8', and 'Mass number' points to '15.99'.

<b>8</b>
<b>O</b>
<b>Oxygen</b>
<b>15.99</b>

# Chemistry Vocabulary

Examples of number of protons, electrons:

- Oxygen
  - 8 protons, 8 electrons
- Gold
  - 79 protons, 79 electrons

Difference between neutral atoms and ions:

- Neutral Atoms
  - Same number of electrons & protons
  - This what you read off the periodic table
- Ions
  - Atoms that have either lost or gained electrons
    - Positive ions are **cations**
    - Negative ions are **anions**

Ca

Ca<sup>+2</sup>

O<sup>-2</sup>

# Chemistry Vocabulary

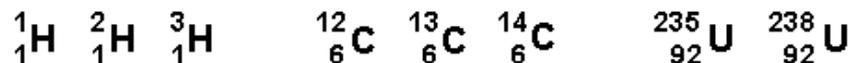
- Two atoms of the same element can have differing numbers of neutrons. These are called *isotopes*
  - Different atomic masses
- Hydrogen has three isotopes:
  - Hydrogen with 1 proton and 0 neutrons
  - Deuterium with 1 proton and 1 neutron
  - Tritium with 1 proton and 2 neutrons

Remember!!

Periodic table lists the  
*Average mass number*

## Isotopes

❖ isotopes:



❖ isotopic abundance:  $\frac{\# \text{ atoms of isotope present}}{\# \text{ atoms of element present}}$

isotope	natural abundance	mass (amu)
carbon-12	98.89 %	12.000000
carbon-13	1.11 %	13.003354
average mass: 12.01 <sub>11</sub> amu		

# Chemistry Vocabulary

- Isotopes written 2 different ways
  1. Chlorine – 35
    - means it has mass of 35
    - How many neutrons does it have?
      - From periodic table atomic number = 17 protons
      - # neutrons = 35 (mass #) – 17 (atomic #)
      - # neutrons = 18

2.



## EXAMPLE:

How many protons, neutrons and electrons are found in an atom of



Atomic number = protons and electrons

There are 55 protons and 55 electrons

Mass number = sum of protons and neutrons

$$133 - 55 = 78$$

There are 78 neutrons

One **atomic mass unit** (amu) is defined as 1/12th the mass of a carbon-12 atom

- One amu is nearly, but not exactly, equal to one proton and one neutron
- Carbon 12 is assigned an atomic mass of 12.00 g
- 12.00 is one atomic mass unit

The number of protons and neutrons in an atom is its mass number.

- Atomic numbers are whole numbers
- Mass numbers are whole numbers
- The atomic mass is not a whole number
- The **atomic mass** of an element is the weighted average mass of the isotopes of that element.