

# Chapter 3



Chemical Foundations: Elements,  
Atoms, and Ions

# Elements

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## □ Ancient Greeks (~450 B.C.)

- Recognized \_\_\_\_\_
  - \_\_\_\_\_
- Did not place particular importance on \_\_\_\_\_

## □ Alchemists

- Tried to turn \_\_\_\_\_
- Did not recognize \_\_\_\_\_

# Elements

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- Robert Boyle (1627-1691)

- Recognized the importance of \_\_\_\_\_

\_\_\_\_\_

- Element: any substance which \_\_\_\_\_

\_\_\_\_\_

- Probably best known for his work on \_\_\_\_\_

- Boyle's Law

- Like alchemists, did not recognize \_\_\_\_\_

\_\_\_\_\_

# Elements

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- About \_\_\_\_\_ known elements
- \_\_\_\_\_ naturally occurring elements
- Combined into \_\_\_\_\_ to make \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- 9 most abundant make up \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
  - Oxygen alone accounts for \_\_\_\_\_

# Abundance of the Elements

## TOP TEN

### Elements in the Human Body

Element	Mass Percent
1. Oxygen	65.0
2. Carbon	18.0
3. Hydrogen	10.0
4. Nitrogen	3.0
5. Calcium	1.4
6. Phosphorus	1.0
7. Magnesium	0.50
8. Potassium	0.34
9. Sulfur	0.26
10. Sodium	0.14

TABLE 3.1

### Distribution (Mass Percent) of the 18 Most Abundant Elements in the Earth's Crust, Oceans, and Atmosphere

Element	Mass Percent	Element	Mass Percent
oxygen	49.2	titanium	0.58
silicon	25.7	chlorine	0.19
aluminum	7.50	phosphorus	0.11
iron	4.71	manganese	0.09
calcium	3.39	carbon	0.08
sodium	2.63	sulfur	0.06
potassium	2.40	barium	0.04
magnesium	1.93	nitrogen	0.03
hydrogen	0.87	fluorine	0.03
		all others	0.49

# 4 Meanings of “Element”

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- A single atom of a given element
  - \_\_\_\_\_
- A measureable amount of a given element
  - \_\_\_\_\_
- Microscopic or macroscopic samples of  
\_\_\_\_\_  
\_\_\_\_\_
- A generic reference to an element on the periodic table
  - Without reference to micro/macro, molecules, compounds

# Element Names

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- Names of elements often come from

- Helium comes from the Greek \_\_\_\_\_

- Some elements are named for \_\_\_\_\_

- \_\_\_\_\_

- Sometimes elements are named for \_\_\_\_\_

- \_\_\_\_\_

# Element Symbols

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□ Abbreviation for element

■ \_\_\_\_\_

□ Sometimes symbol is \_\_\_\_\_

■ \_\_\_\_\_

□ Sometimes \_\_\_\_\_

■ \_\_\_\_\_

□ Sometimes symbol is \_\_\_\_\_

■ \_\_\_\_\_

# Element Symbols

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- Sometimes element symbol seems to have nothing to do with the element name

- \_\_\_\_\_

- Symbol is based on \_\_\_\_\_

- Gold (Au) = \_\_\_\_\_

- Lead (Pb) = \_\_\_\_\_

- Wherever the symbols come from, we use them \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

# The Elements

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- The Element Song

- [www.privatehand.com/flash/elements.html](http://www.privatehand.com/flash/elements.html)

- New Periodic Table Song

- <http://safeshare.tv/w/vfhyINFIyX>

# Is matter discrete or continuous?

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- How many times can we cut a piece of Aluminum foil in half?

- \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- Do we ever get to a point where the Aluminum can no longer be cut?

- \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

# The Atomists

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- ❑ Idea originates with \_\_\_\_\_
- ❑ Group called \_\_\_\_\_ led by \_\_\_\_\_
- ❑ Atomos = parts of matter that are \_\_\_\_\_
- ❑ All matter is composed of \_\_\_\_\_
- ❑ Properties of matter are based on \_\_\_\_\_  
of atoms it is made from (not limited to just 4  
basic elements)

# Aristotle has a problem

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□ Aristotle and others have a problem with the idea of atoms which include:

□ \_\_\_\_\_

□ \_\_\_\_\_

□ \_\_\_\_\_

□ Democritus \_\_\_\_\_

# Lavoisier, Proust, and Dalton

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- ~2200 years later scientists revisit atoms
- Mid 1700's – Antoine Lavoisier
- Law of \_\_\_\_\_
- 1794 – Joseph Proust
- Law of \_\_\_\_\_
- 1808 John Dalton
  - \_\_\_\_\_

# Dalton's Atomic Theory

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- Elements \_\_\_\_\_
- All atoms of an element are \_\_\_\_\_  
and are \_\_\_\_\_  
\_\_\_\_\_
- Atoms cannot be \_\_\_\_\_  
\_\_\_\_\_
- A compound always has \_\_\_\_\_  
\_\_\_\_\_
- In a chemical reaction, atoms are \_\_\_\_\_  
\_\_\_\_\_

# Dalton's Atomic Theory

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- Elements are composed of atoms

- Similar to \_\_\_\_\_

- Idea of \_\_\_\_\_ has changed since ancient Greeks ~ \_\_\_\_\_ "modern" elements known in 1808

- Today: atom is the smallest unit \_\_\_\_\_  
\_\_\_\_\_

# Dalton's Atomic Theory

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- Atoms of an element are identical and different from atoms of another element
  - Not entirely true today
  - Atoms of an element have same \_\_\_\_\_
  - May differ in \_\_\_\_\_
  - Different number of neutrons= \_\_\_\_\_
  - Atoms gain or lose electrons= \_\_\_\_\_

# Dalton's Atomic Theory

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□ Atoms cannot be subdivided, created, or destroyed

■ Restates \_\_\_\_\_

■ Dalton: Atoms are \_\_\_\_\_ like \_\_\_\_\_ and are \_\_\_\_\_

■ Today: \_\_\_\_\_

■ Today: Fission = \_\_\_\_\_  
\_\_\_\_\_

■ Today: Fusion = \_\_\_\_\_  
\_\_\_\_\_

# Dalton's Atomic Theory

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□ A compound always has the same ratio of atoms of each of its elements

■ Proust's Law of \_\_\_\_\_

■ Ex. water is always \_\_\_\_\_

□ \_\_\_\_\_ give the ratio of atoms of each element in a compound – do not write \_\_\_\_\_

■ Multiple proportions

□ The same elements can \_\_\_\_\_

# Dalton's Atomic Theory

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- Atoms are conserved in chemical processes
  - Explanation of Law of \_\_\_\_\_  
\_\_\_\_\_
  - A chemical reaction is just a change in \_\_\_\_\_  
\_\_\_\_\_
  - Chemical equations must be \_\_\_\_\_  
\_\_\_\_\_

# Dalton's Atomic Theory

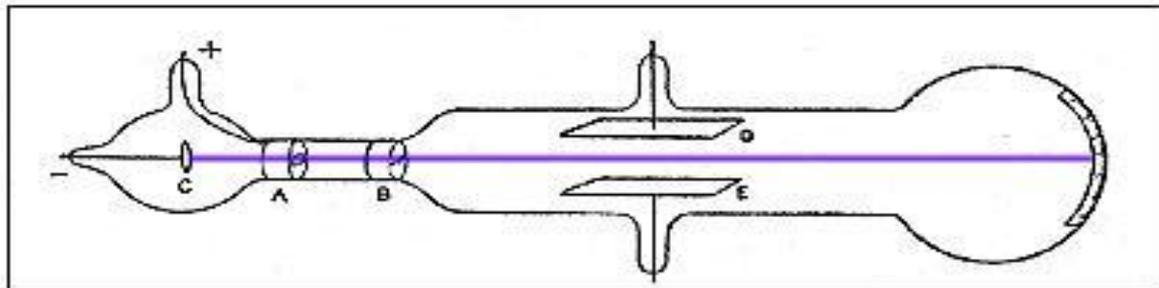
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- Still leaves old questions about atoms
  - What causes them to stick together
  - Hard to verify if you can't see them
  - Are atoms like marbles?
  - Are atoms hollow? Are they solid?
  - Do atoms have parts?
  
- These questions go unanswered for most of the 19<sup>th</sup> century

# The Structure of the Atom

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- \_\_\_\_\_ nature of matter
- 1890's J.J. Thomson's \_\_\_\_\_ experiments
  - Any element can eject \_\_\_\_\_
  - Negative particles = \_\_\_\_\_
  - Electron comes from Greek word for \_\_\_\_\_
  - Electron is first \_\_\_\_\_

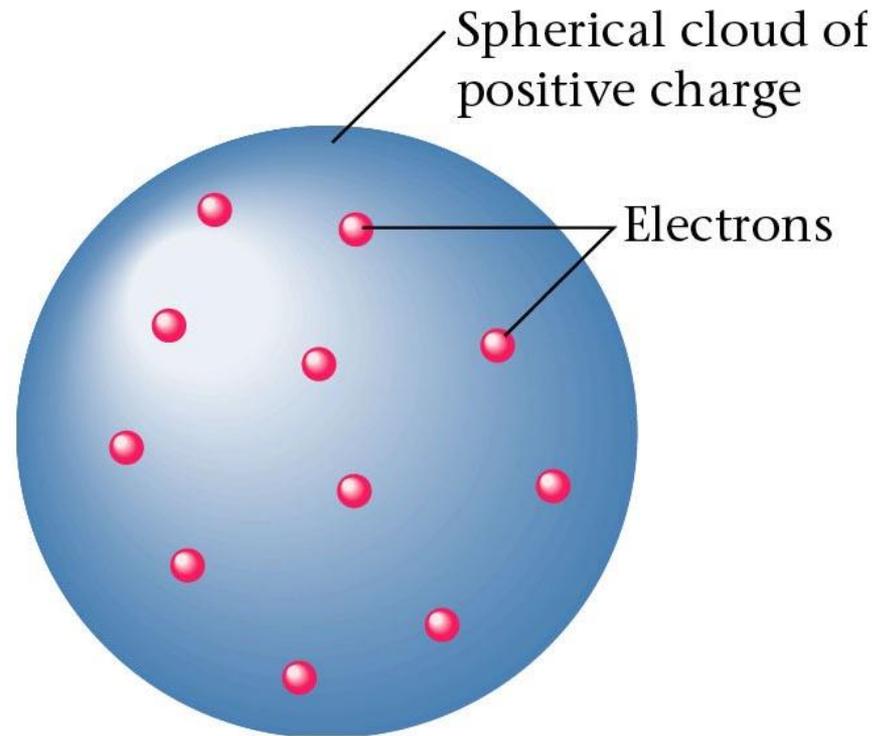


# The Structure of the Atom

- Charge \_\_\_\_\_
- \_\_\_\_\_ model  
– \_\_\_\_\_
- \_\_\_\_\_

## Model – Eric Butler

- \_\_\_\_\_ is  
\_\_\_\_\_ charged
- \_\_\_\_\_ are  
nuggets of \_\_\_\_\_
- Positive/negative charge  
\_\_\_\_\_



# Cathode Ray Tube

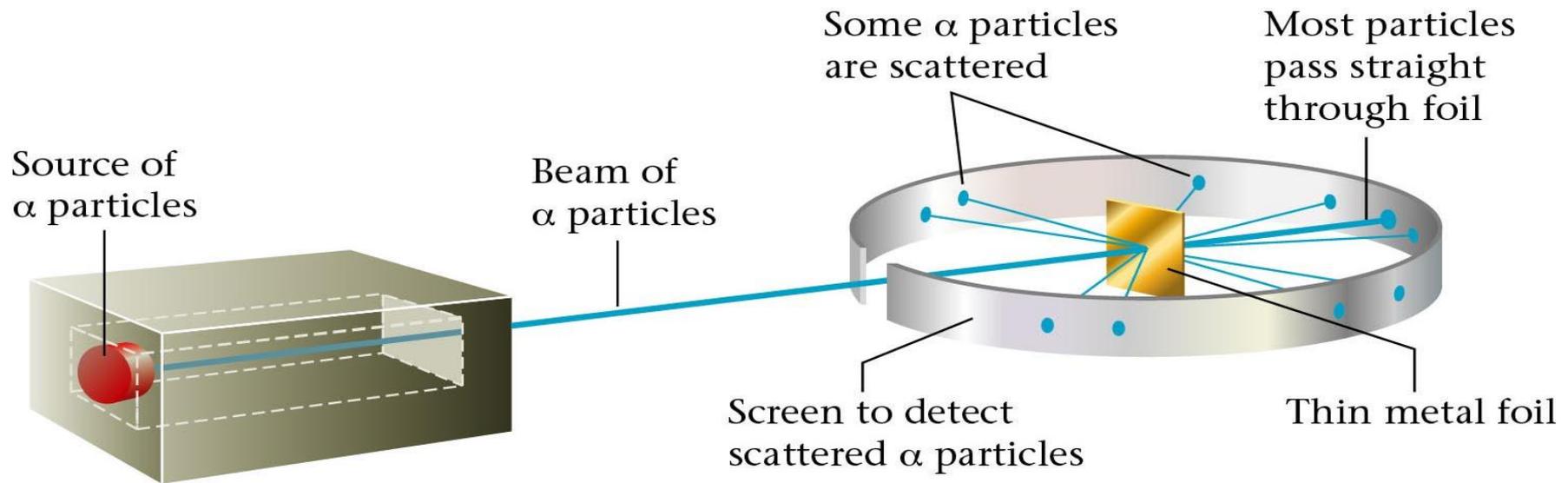
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- Thomson's Experiments Explained
  - <http://safeshare.tv/w/AjRuHXvDcn>

# The Structure of the Atom

## Ernest Rutherford

## Experiment



# Rutherford's Gold Foil Experiment

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- [Video of the gold foil experiment](#)
  - [www.youtube.com/watch?v=5pZj0u\\_XMbc](http://www.youtube.com/watch?v=5pZj0u_XMbc)

# Gold Foil Experiment

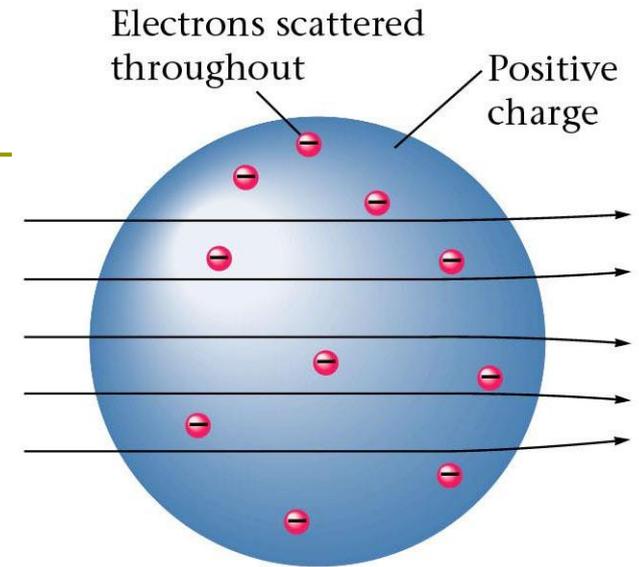
- What does this tell us about the structure of the atom?
- Positive charge of atom is

\_\_\_\_\_

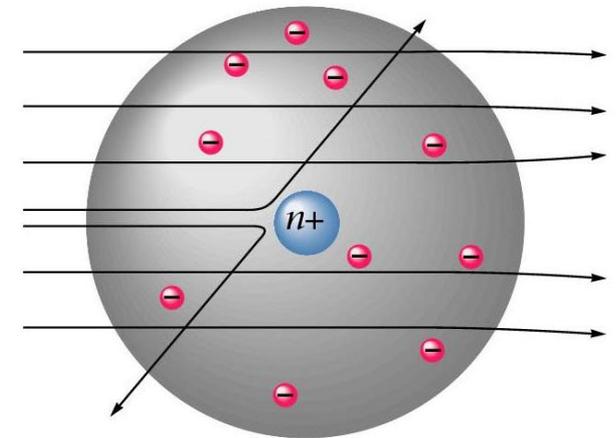
\_\_\_\_\_

- Rutherford called this the \_\_\_\_\_ of the atom

- Most of the atom is \_\_\_\_\_ where \_\_\_\_\_ are found



(a)



(b)

# Ernest Rutherford

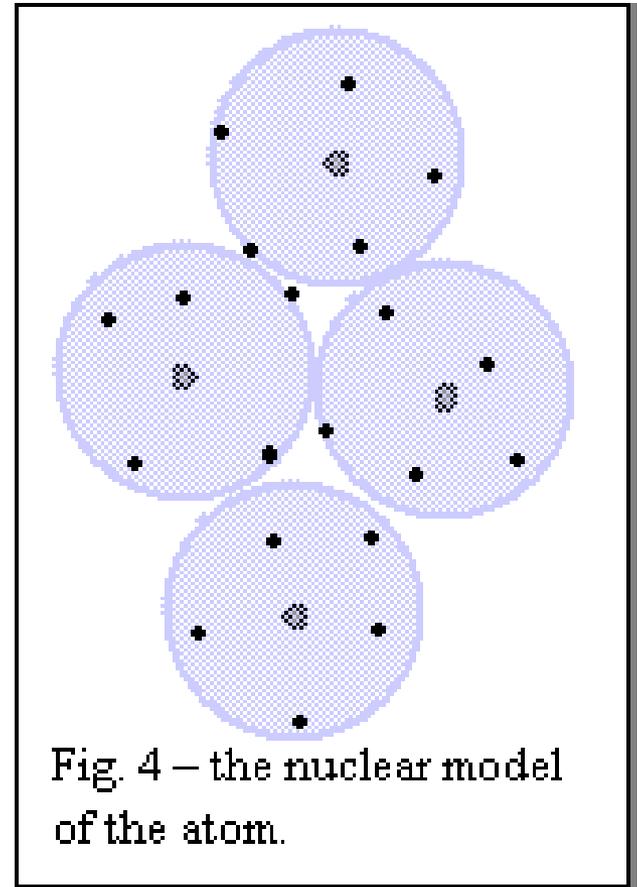
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- Positive charge comes from \_\_\_\_\_
- Protons have \_\_\_\_\_ charge as electrons but \_\_\_\_\_ sign
- Hydrogen has \_\_\_\_\_, other elements have \_\_\_\_\_
- Electrons are found \_\_\_\_\_
- Protons held together in nucleus by \_\_\_\_\_
- Neutrons have \_\_\_\_\_ than protons but \_\_\_\_\_

# The Nuclear Atom

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- Nucleus = \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- Nucleus contains \_\_\_\_\_  
and \_\_\_\_\_
- Rest of atom is \_\_\_\_\_  
\_\_\_\_\_
- \_\_\_\_\_ found  
far from nucleus



# Protons, Neutrons, and Electrons

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particle	charge	mass	location
proton			
neutron			
electron			

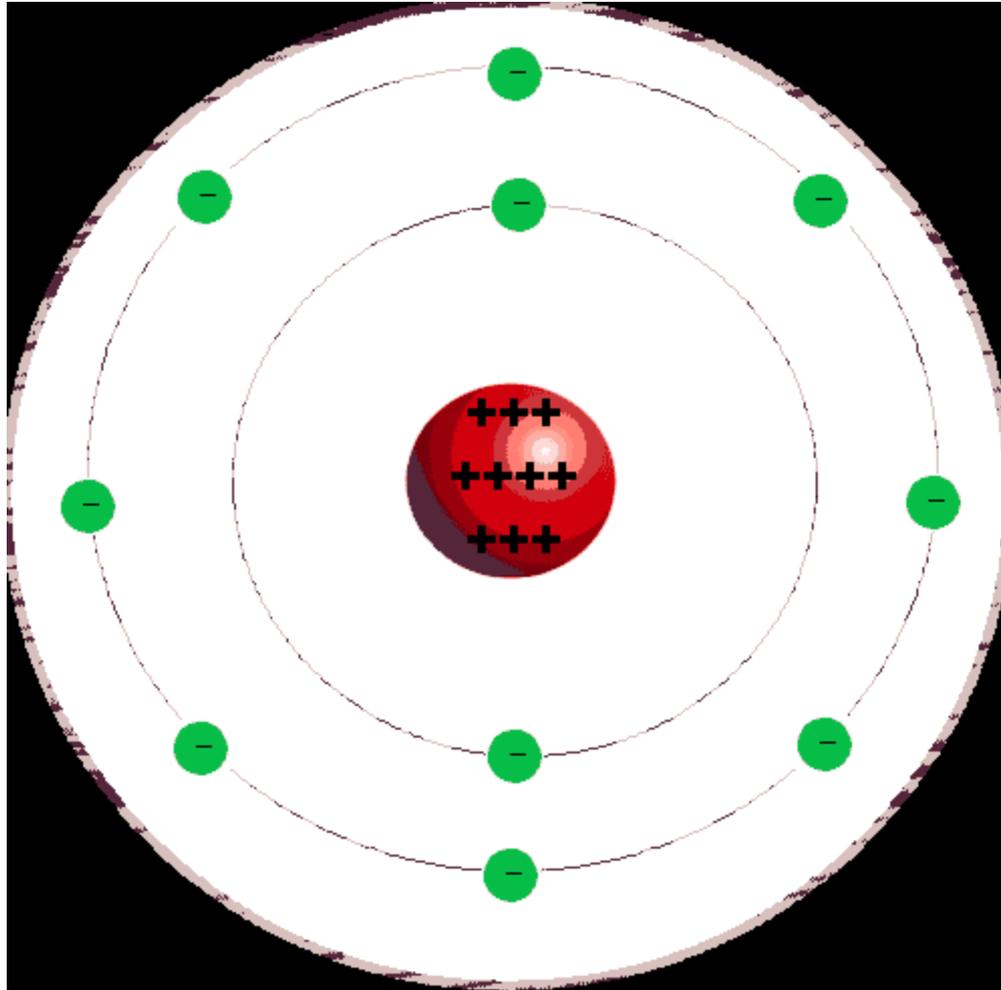
# Bohr Model of the Atom

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- Niels Bohr – \_\_\_\_\_
- \_\_\_\_\_ nucleus with \_\_\_\_\_
- Electrons move around nucleus \_\_\_\_\_
- Orbits can be farther away or closer to nucleus depending on \_\_\_\_\_
- Electrons exist in energy levels
- Electrons can move up and down through levels as \_\_\_\_\_

# Bohr Model of the Atom

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# Bohr Model of the Atom

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## □ Problems with the Bohr Model

- Only works well for \_\_\_\_\_
- Electrons are \_\_\_\_\_
- Heisenberg \_\_\_\_\_

- Bohr model did provide idea of energy levels which is retained in modern model

# Modern Model of the Atom

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- \_\_\_\_\_ nucleus
- Protons and neutrons \_\_\_\_\_
- Electron \_\_\_\_\_
- Electrons occupy \_\_\_\_\_
  - Area of \_\_\_\_\_
  - Exact path of movement is \_\_\_\_\_
  - Electrons act as both \_\_\_\_\_
  
- Modern model is a \_\_\_\_\_ model rather than a \_\_\_\_\_ model

# To Recap

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- [The 2400 Year Search for the Atom](#)
  - <http://safeshare.tv/w/mOHLKLSiiX>
  
- [History of Atomic Chemistry – Crash Course](#)
  - <http://safeshare.tv/w/XUCkKLxpjR>

**END OF MATERIAL FOR QUIZ**