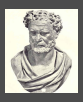
CHAPTER 17
PROPERTIES OF ATOMS AND THE PERIODIC TABLE

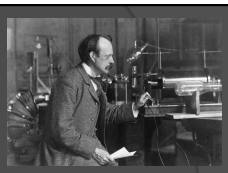
History of the Atom




- 400 B.C. – Democritus and Leucippus
  - Greek philosophers
  - matter is made up of tiny indivisible particles called *atomos* (means uncuttable)
- 400 B.C. – Aristotle

  - Greek philosopher
  - matter is made up of 4 basic elements: earth, air, water, and fire

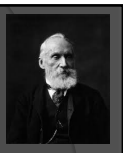
- 1808 – John Dalton
  - English school teacher
  - developed an Atomic Theory
  1. elements are made up of atoms
  2. atoms of an element are the same, but different than atoms of other elements
  3. atoms are neither created nor destroyed in a chemical reaction
  4. a given compound always has the same relative numbers and kinds of atoms



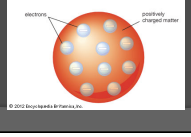
- 1897 – J. J. Thomson
  - English Physicist
  - worked with cathode ray tubes
    - glass tubes full of gases with phosphorescent screens in them

https://www.youtube.com/watch?v=O9Goyscbazk

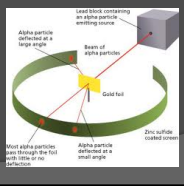
  - discovered the electron



- 1903 – William Thomson (Lord Kelvin)
  - no relation to J.J. Thomson
  - English Physicist and Engineer
  - imagined the atom must have positive particles to balance out the negative particles
- J.J. Thomson called this idea the "plum

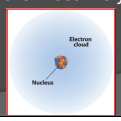


- 1911 – Ernest Rutherford
  - Physicist from New Zealand
  - discovered the nucleus
    - famous gold foil experiment
  - 1919 - he concluded that the nucleus contain protons



- 1915 – Niels Bohr
  - Physicist from Denmark
  - came up with a new model of the atom; the planetary model
    - the atom is a positively charged center with electrons moving around it in orbits like planets moving around the sun

- 1926 - Electron Cloud Model
  - developed by Erwin Schrödinger and Werner Heisenberg
  - the position of an electron is not predictable, but that the probability of its location is within the electron cloud
    - area around the nucleus of an atom where the atom's electrons are most likely to be found



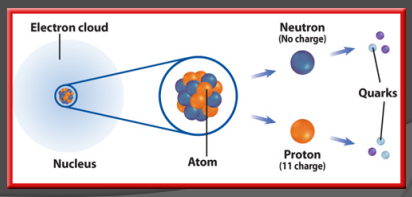
- 1932 – James Chadwick
  - Physicist from England
  - worked with Rutherford
  - discovered the neutron

Section 17.1: Structure of the Atom

- Scientific shorthand
  - chemical symbols – used to represent elements
  - **element**
    - matter that is composed of one type of *atom*
  - chemical formulas
    - used to represent compounds
    - consist of chemical symbols and subscripts
    - NaCl
    - H_2O

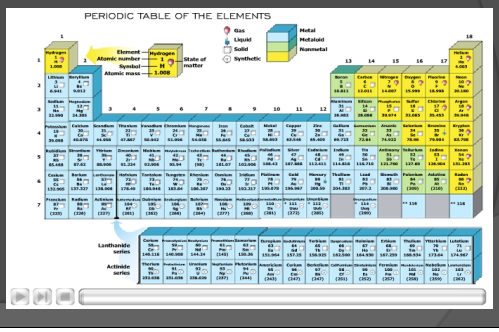
- **atom**
  - the smallest particle of an element that still retains the properties of the element
  - composed of protons, neutrons, and electrons
- **proton** (p^+)
  - particle inside the nucleus of an atom that has a charge of 1+
- **neutron** (n^0)
  - neutral particle inside the nucleus of an atom

- **nucleus**
  - positively charged center of an atom that contains protons and neutrons and is surrounded by a cloud of electrons
- **quarks**
  - particles of matter that make up protons and neutron



- **electron cloud**
  - area around the nucleus of an atom where the atom's electrons are most likely to be found
- **electrons** (e^-)
  - particles surrounding the center of an atom that have a charge of 1-

Section 17.2: Masses of Atoms



- **atomic number**
  - number of protons in an atom's nucleus
  - found above the chemical symbol on the periodic table
  - equals the number of electrons in a neutral atom
- **atomic # = protons = electrons**

- the nucleus contains most of the mass in an atom
  - protons and neutrons are more massive than electrons
- the unit of measurement for atomic particles is the atomic mass unit (amu)
- the mass of a proton or a neutron is almost equal to 1 amu
- What is the mass, in amu, of an atom with 1 proton and 2 neutrons?
  - 3 amu

Subatomic Particles

element	symbol	atomic #	mass #	protons	neutrons	electrons
Sulfur						
Tungsten						
Zinc						
Uranium						

Name	Symbol	Atomic #	Mass #	p^+	e^-	n^0
1. hydrogen						
2. beryllium						
3. silicon						
4. krypton						
5. aluminum						
6. helium						
7. carbon						
8. nitrogen						
9. polonium						
10. xenon						
11. radon						
12. phosphorus						
13. boron						
14. neon						
15. argon						
16. scandium						

Name	Symbol	Atomic #	Mass #	p^+	e^-	n^0
17. vanadium						
18. chromium						
19. silver						
20. cadmium						
21. iron						
22. lead						
23. iodine						
24. potassium						
25. lithium						
26. manganese						
27. cobalt						

Isotopes

- not all atoms of the same element have the same number of neutrons
- **isotopes**
  - atoms of the same element that have different numbers of neutrons
- the **average atomic mass** of an element is the weighted-average mass of the mixture of its isotopes

symbol used for isotopes

$${}^{A}_{Z}X$$

- *A = mass #*
- *Z = atomic #*
- *X = element symbol*

- ***please note this is different then how they are arranged on the periodic table***

naming isotopes

- we identify isotopes of elements by their name or symbol and their mass number

$${}^{14}_{6}C$$

$${}^{238}_{92}U$$

$${}^{230}_{90}Th$$

symbol	name	atomic number	mass number	p^+	n^0	e^-
Sr						
${}^{14}_{6}C$						
${}^{77}_{35}Br$						
${}^{206}_{82}Pb$						
Ca						
${}^{236}_{92}U$						

Section 17.3: The Periodic Table

- Dmitri Mendeleev – 1869
  - Russian Chemist
  - he searched for a way to organize the elements
  - he arranged in order of increasing atomic mass
    - discovered a pattern that repeated (periodic)
    - the arrangement of elements is known as The Periodic Table of Elements

Improving the Periodic Table

- Mendeleev's table
  - the mass gradually increases from left to right
- Modern Periodic Table
  - the mass decreases in some places, such as cobalt and nickel
  - Henry Moseley – 1914
    - led to the arrangement of elements based on atomic number

The Atom and the Periodic Table

- **group**
  - vertical columns in the periodic table
  - also known as families
  - there are 18 groups, but using the Roman numerals, there are 8 main groups
  - elements in the same group have similar properties

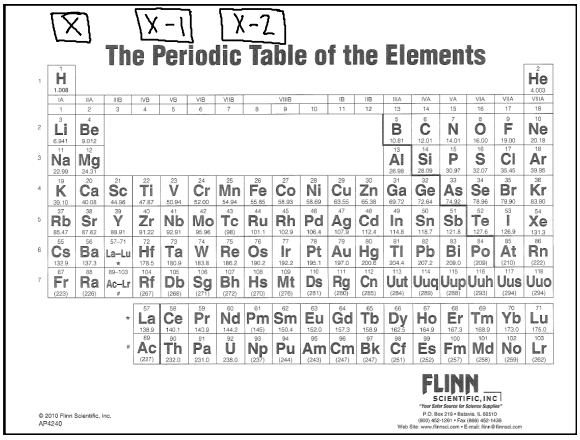
- **period**
  - horizontal rows in the periodic table
  - there are 7
  - corresponds to the shell number (for electron placement)

Electron Cloud Structure

- electrons in the electron cloud have different amounts of energy
  - energy level close to the nucleus
    - low energy
  - energy level farther away from the nucleus
    - high energy
  - electrons fill these energy levels from the inner levels to the outer levels
- elements in the same groups have the same number of electrons their outer energy level

Flame Tests

- http://chemistry.bd.psu.edu/jircitano/periodic4.html



Electron Arrangement

- neutral atom
  - atomic number = protons = electrons
  - Carbon - Atomic #6
    - 6 protons
    - 6 electrons

Electron Arrangement

- Periods 1-7 correspond to each shell number
  - each element will represent 1 electron
  - x = shell number
- Maximum # of electrons for each shell
  - $2x^2$ where x = shell #
- use the periodic table to help you determine which shells the electrons go in

Energy Levels

Shell #	Maximum # of electrons
1	$2(1)^2 = 2$
2	$2(2)^2 = 8$
3	$2(3)^2 = 18$
4	$2(4)^2 = 32$
5	$2(5)^2 = 50$
6	$2(6)^2 = 72$
7	$2(7)^2 = 98$

- **octet rule**
  - atoms tend to gain, lose or share electrons to get eight electrons in their outer energy level
- **valence electrons**
  - electrons in the outermost energy level of an atom

Examples of electron arrangements

- Carbon

- Silicon

- Nickel

- Cadmium

Practice: Electron Arrangements

- Draw the electron arrangements for the following elements.
  - Boron
  - Magnesium
  - Chromium
  - Strontium

Electron Dot Diagrams

- **electron dot diagram**
  - uses the symbol of the element and dots to represent the electrons in the outer energy level (valence electrons)
  - the main group the element is in will tell you how valence electrons it has (except Helium, it only has 2 electrons)
- Example
  - Nitrogen is in group VA (5A)
  - 5 valence electrons