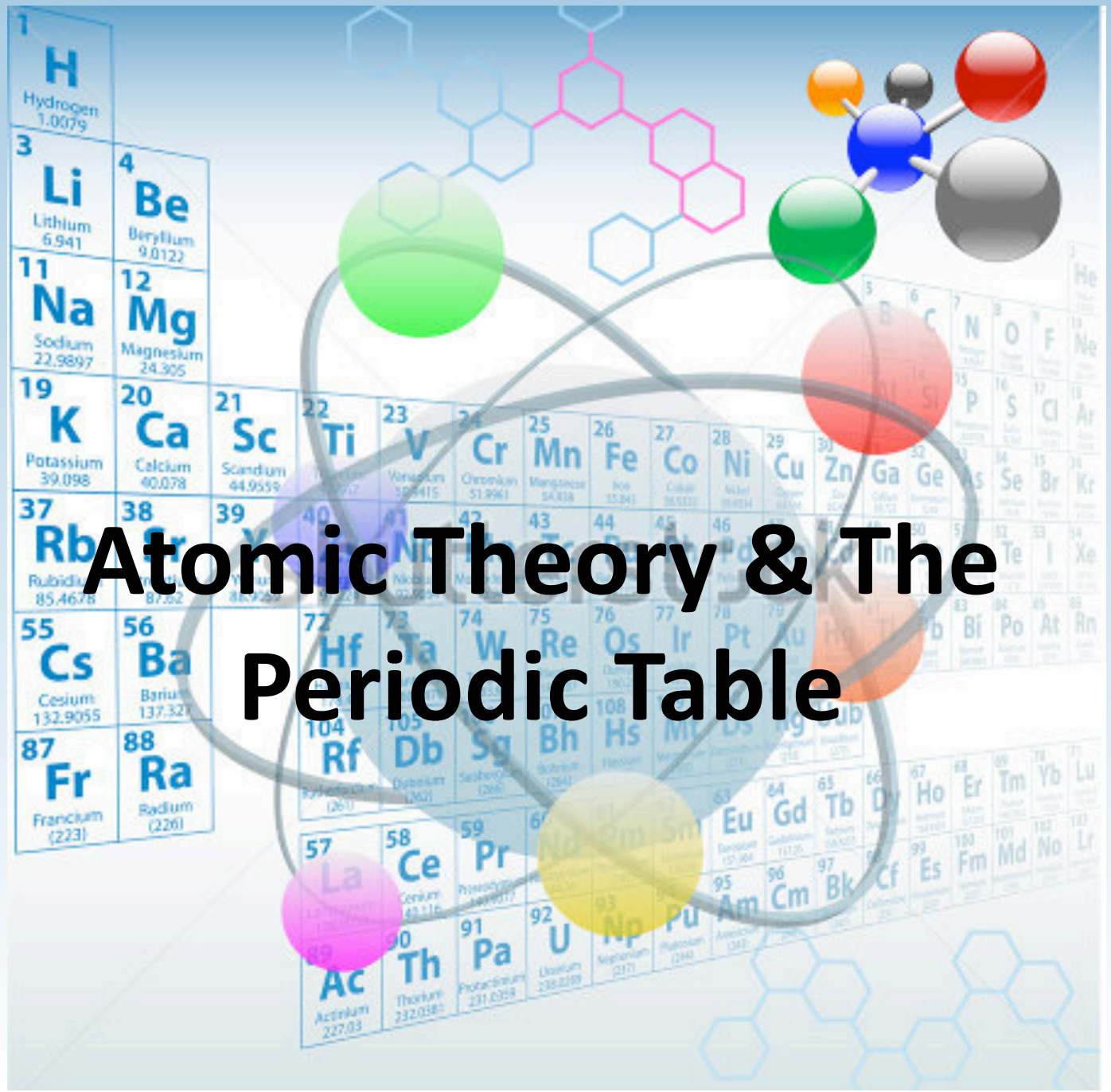
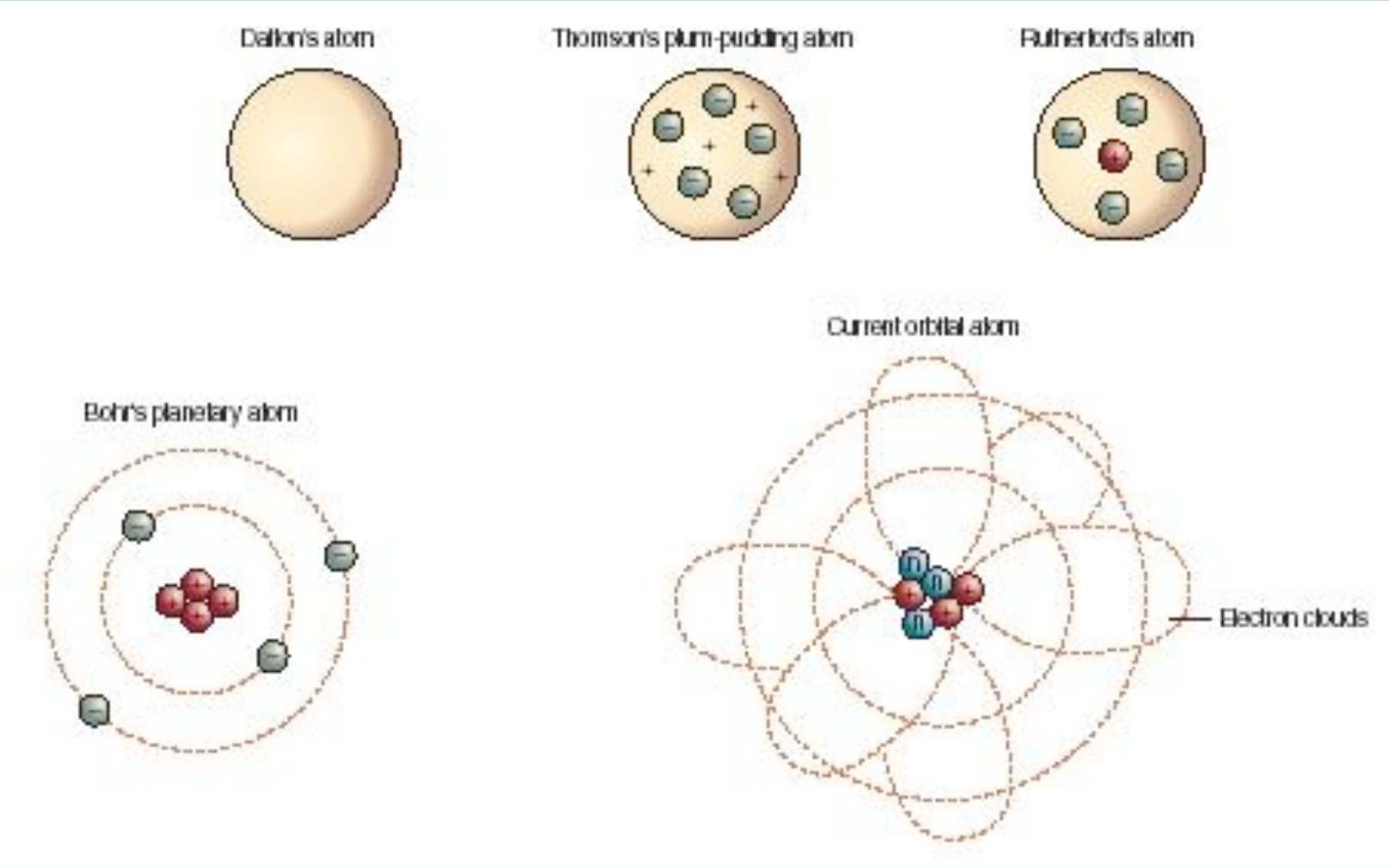
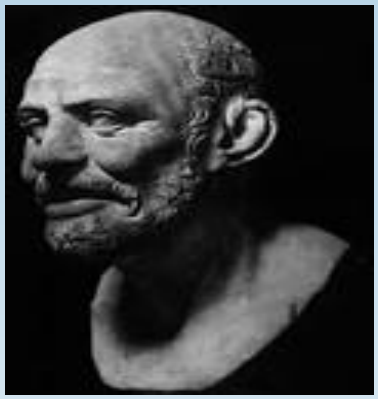

Atomic Theory & The Periodic Table

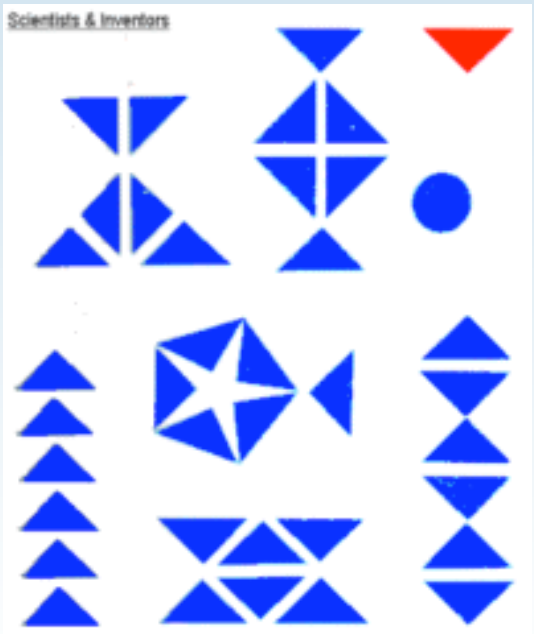
Atomic Theory



The Beginning of Atomic Theory

- 440 BC – Greek philosopher, Democritus thought all materials could be cut in half over and over until they reached the size of one atom
- **Atom** = Greek for "not able to be divided"
- **Democritus' Theory:** all atoms are small, hard particles made of one material formed into different shapes and sizes



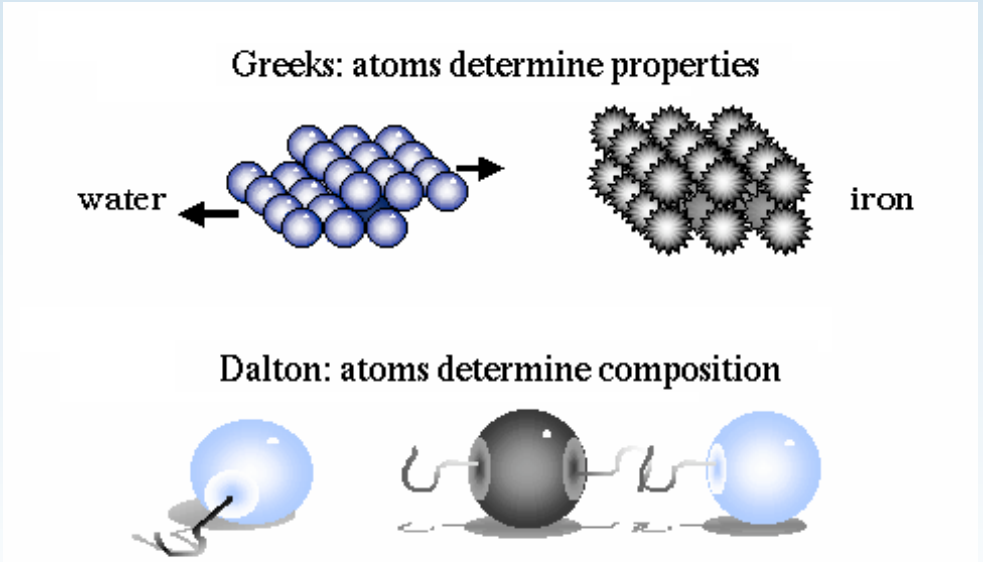


Dalton's Atomic Theory

- **John Dalton** – British chemist and school teacher (late 1700's – early 1800's)
- Wanted to know <u>why elements always combine in certain ways</u>
  - (H and O always combine in same proportions to make water)
- His experiments show it happens because <u>elements are made of single atoms</u>

- 1803 – Dalton's Theory:
  - All substances are made of atoms. Atoms are small particles that can't be created/destroyed.
  - Atoms of the same element are exactly alike, and atoms of different elements are different
  - Atoms join with other atoms to make new substances

Dalton's Theory:
Billiard Ball Atomic Model



Not Quite Right

- Dalton's theory had some good parts, but as more discoveries were made, some parts didn't fit

- So the search continues….

J.J. Thomson's Additions

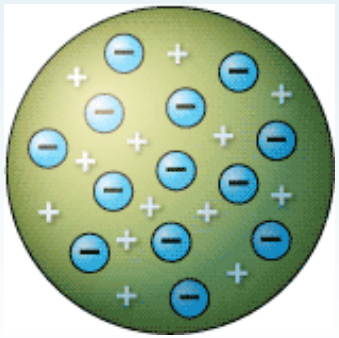
- J.J. Thomson – British scientist in the 1800's
- Showed that Dalton's theory had a flaw – atoms have parts!
- Experimented with a cathode ray and showed that rays bend under the influence of a magnetic field, showing a negative charge
- Negative particles were later named electrons

Thomson's New Model

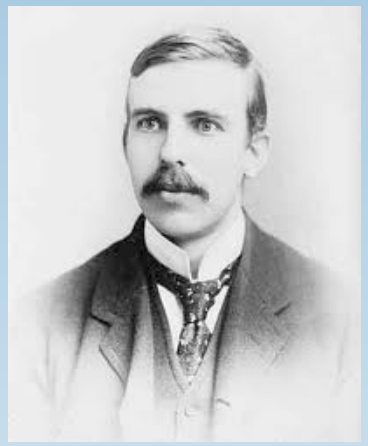
- He thought the atom had an overall positive charge with some electrons, negative charge, floating around.
- This is called the Plum Pudding model of the atom. *(it looked like a common dessert…you might call it chocolate chip ice cream model)*

Dalton

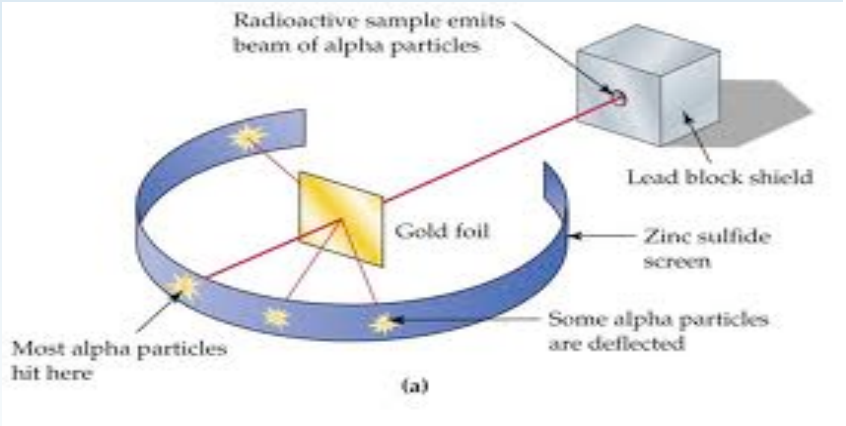
J.J. Thomson



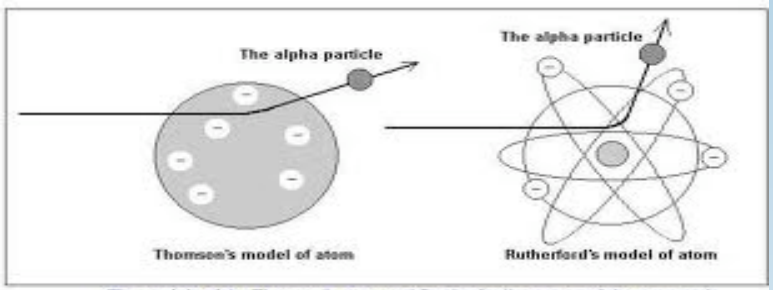
Earnest Rutherford



- Former student of J.J. Thomson
- 1909 - Tested Thomson's theory by studying the parts of an atom in the "Gold Foil Experiment"
- Gold Foil Experiment:
  - Positive particles are shot at an element (gold)
  - If Thompson's model was right, all particles would be evenly deflected since there were +/- charges spread throughout to push/pull the positive particles



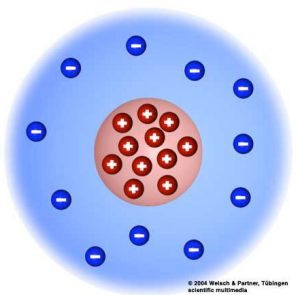
Rutherford's Conclusions & New Model - 1911



The models of the Thomson's atom and Rurtherford's atom; and the expected aberrations of alpha particle in both cases.

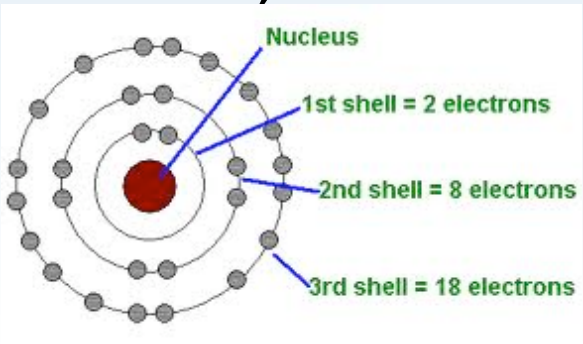
1. Since <u>most</u> of the particles <u>passed through</u> the foil <u>undeflected, therefore most of the atom is empty</u>.
2. Small angles of deflection show that positively charged particles were attracted by electrons. *(negative attracts positive)*
3. Large angles of deflection show that there is a massive positively charged body present in the atom called a nucleus

   (positive strongly repulses positive)

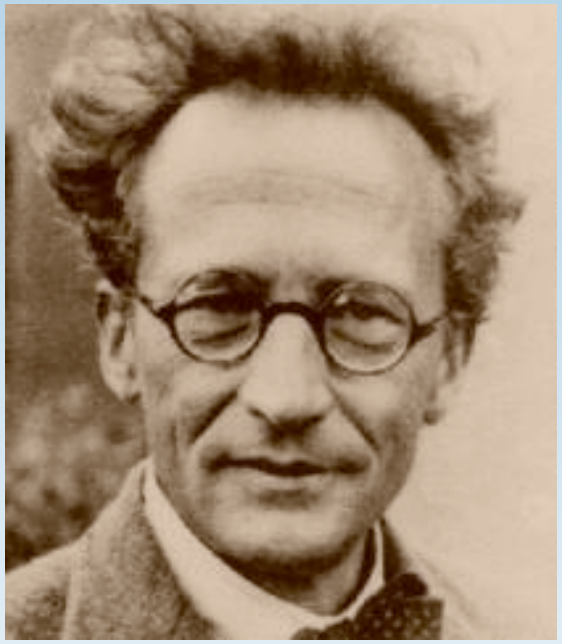


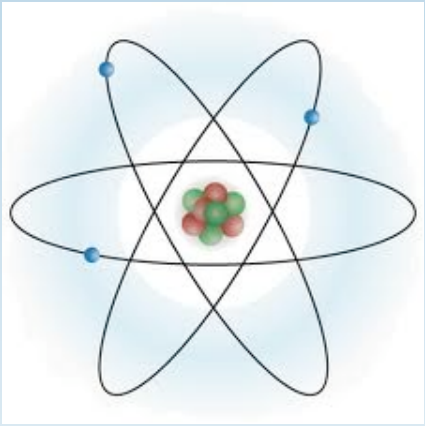
Bohr's Electron Levels

- Niels Bohr – Danish scientist; worked with Rutherford
  - Studied the way atoms react to light
  - Thought electrons move around the nucleus in specific paths (energy levels)
  - Helped predict atomic behavior, but was still flawed



New Evidence for Electrons

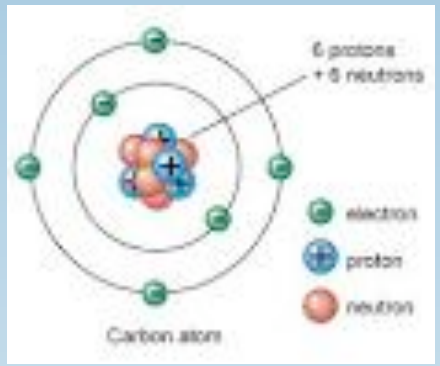




Erwin Schrodinger (Austrian physicist) & Werner Heisenberg (German physicist) - explained how electrons really behave

- Electrons don't have a definite path, but regions where they are likely to be (electron clouds)

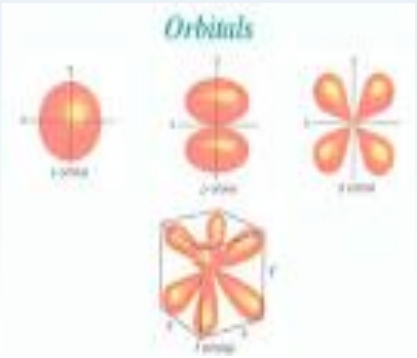
Structure of an Atom



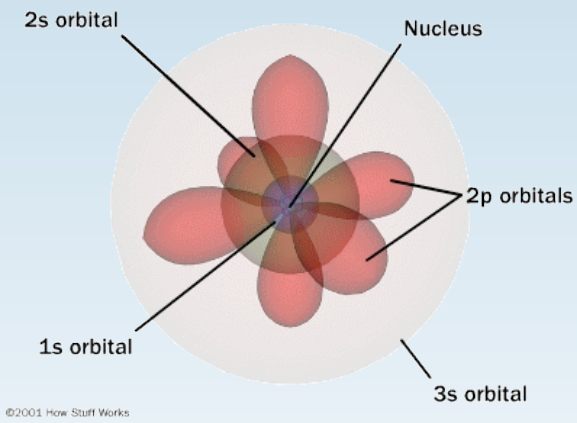
Atoms have 3 parts:

1. Protons – positively charged particle in nucleus
2. Neutrons – neutral particle in nucleus
3. Electrons – negatively charged particles orbiting outside the nucleus

** Electrons are found in many orbits around the nucleus, called orbitals



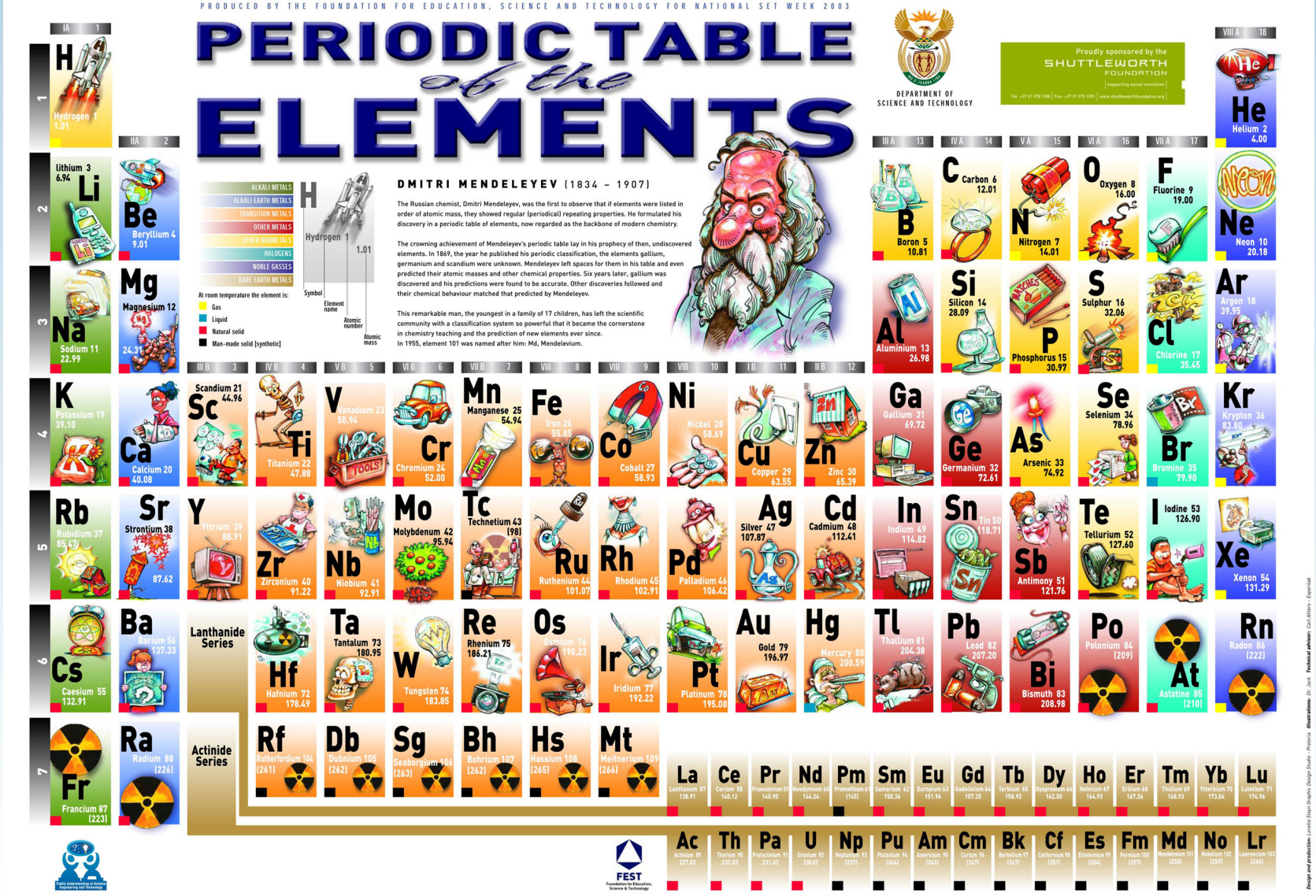
Current Atomic Theory



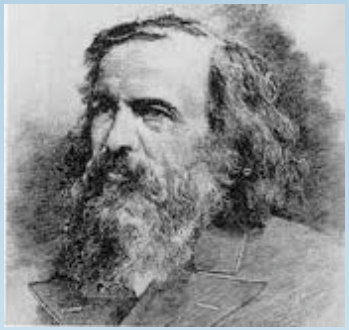
1. Elements are made of small atoms.
2. All atoms of a given element have the same chemical properties and contain the same number of protons.
3. Compounds are made by combining two or more different atoms.
4. Atoms are the units of chemical change.

The Periodic Table of Elements:

Trends Explained by Atomic Theory



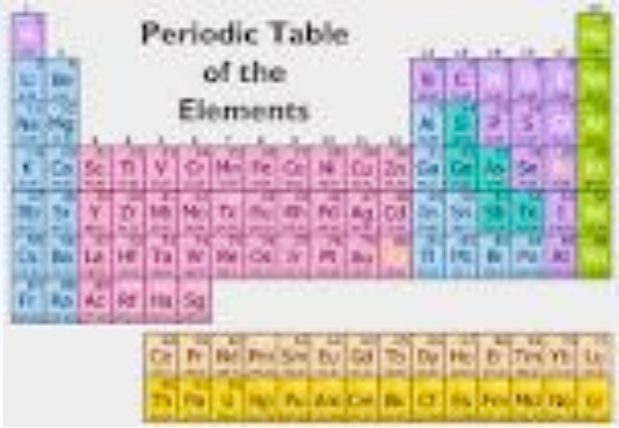
Building the Periodic Table



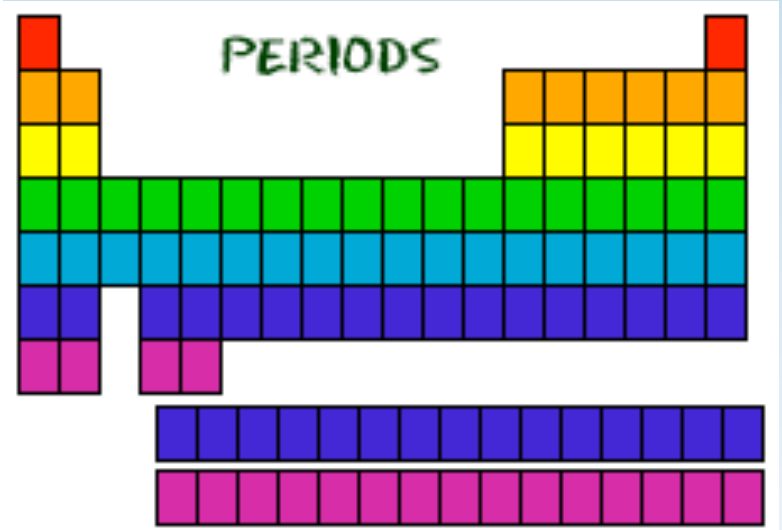
- 1869 – Dmitri Mendeleev arranged the 63 known elements into the periodic table
- Elements are in ascending order (small to big) by atomic weight and grouped by similar properties
- He predicted the existence of elements that had yet to be discovered and corrected accepted atomic weights that were wrong

Elements as Building Blocks

- Periodic Table is organized like a big grid
- Elements are placed in specific places because of how they **look and act**.
- There are **rows** (left to right) and **columns** (up and down)
- **Rows and columns mean different things**



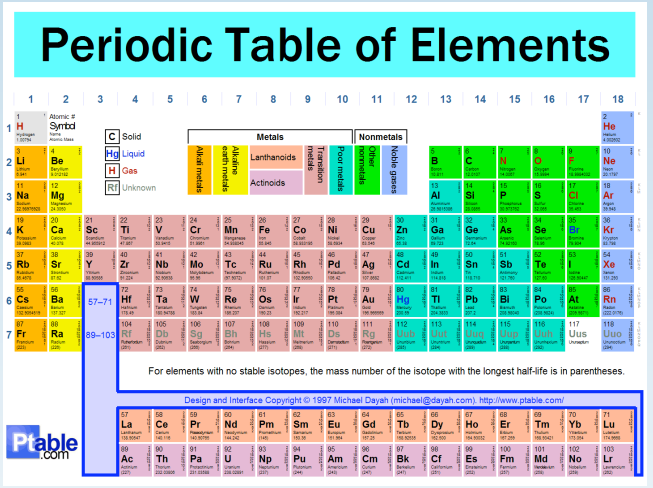
Periods (Rows)



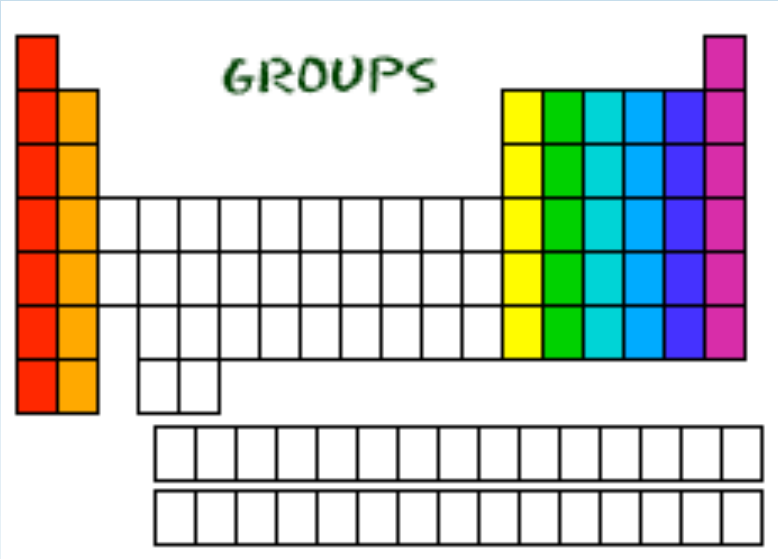
- All of the rows go **left to right** (even if there's big gaps in the row)
- **Each row is a different period**.
- Elements in the same period have the same number of orbitals.

1st and 2nd Period

- Period 1: Hydrogen & Helium
  - 1 orbital
- Period 2: Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen, Fluorine, Neon
  - 2 orbitals
- elements in a period have the **same number of atomic orbitals**
- **The row number (1-7) tells you how many orbitals they have**



Periodic Groups (Columns)

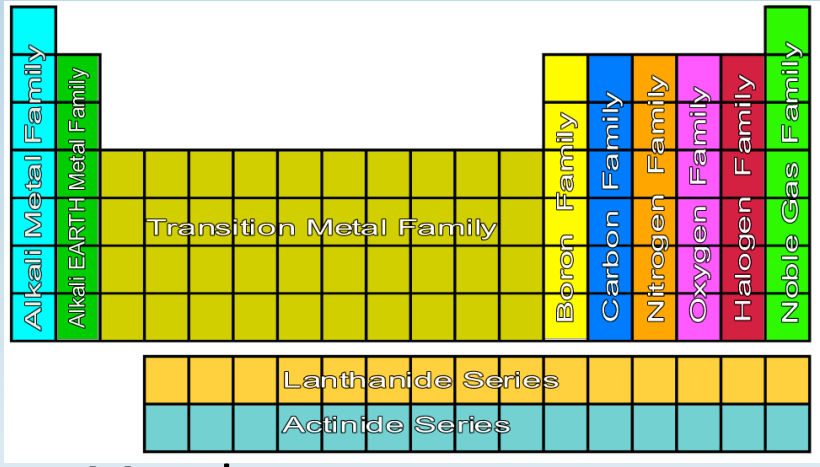


** Transition elements (clear blocks) are an exception

- When a column goes from top to bottom, it's called a **GROUP**
- Groups have a common property: number of outer (valence) electrons
- **Valence Electron:** the number of electrons in the outer most orbital
  - Group 1 (red stripe) has 1 valence electron
  - Group 3 (yellow stripe) has 3 valence electrons
  - Group 8 (purple stripe) has 8 valence electrons

Special Group Names: Families

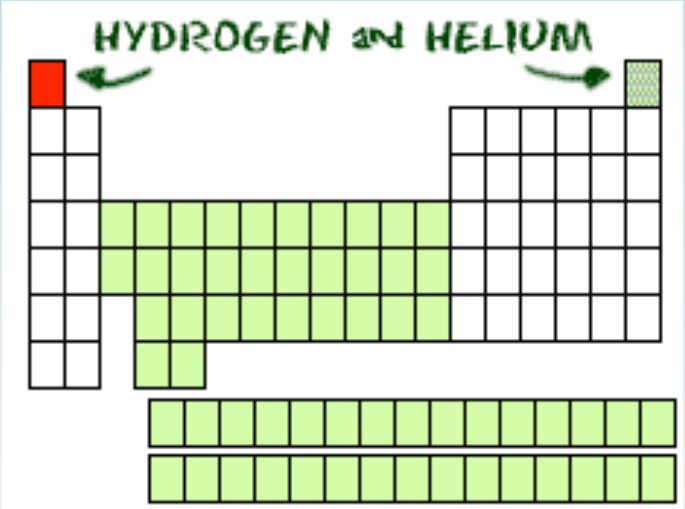
- Several groups have special names and are called families
  - Group 1: Alkali Metals
  - Group 2: Alkaline-Earth Metals
  - Group 7: Halogen Gases
  - Group 8: Noble Gases
  - Groups 1B-8B (middle): Transition Metals



- Families are grouped by their chemical properties

  - Reactivity - Valence Electrons -Radioactivity

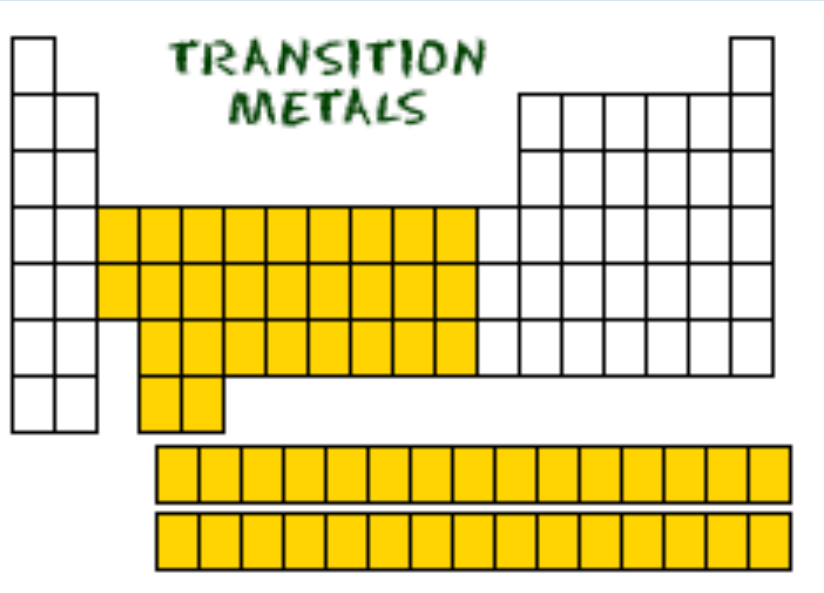
Rule Breakers: Hydrogen & Helium

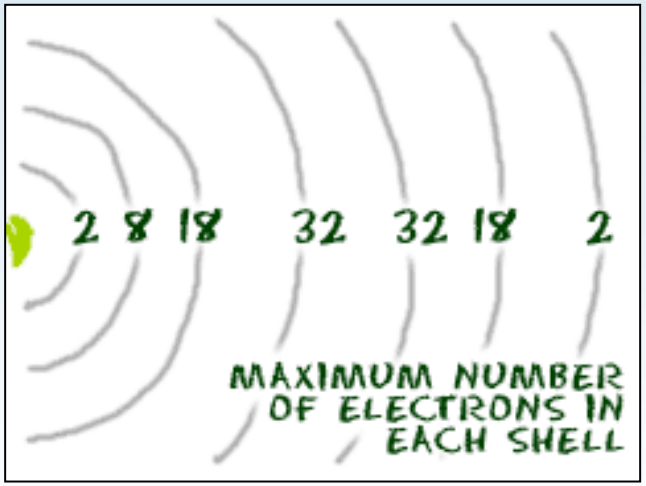


- Hydrogen and Helium are special elements
- Hydrogen can have the talents and electrons of two groups: 1 and 7
  - It's seen as having one extra electron (like group 1) or missing one (like group 7)
- Helium is different from all other elements. It only has two valence electrons, but is grouped with noble gases

Rule Breakers: Transition Metals

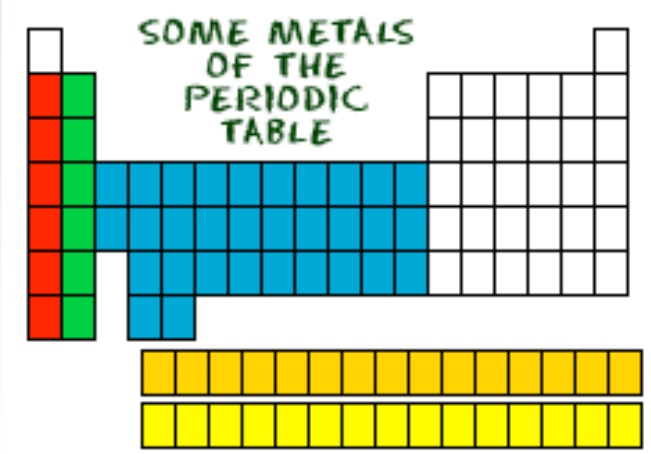
- Transition Metals
  - They live in **the center** of the periodic table
  - They have special electron rules, which allows them to bind with more elements





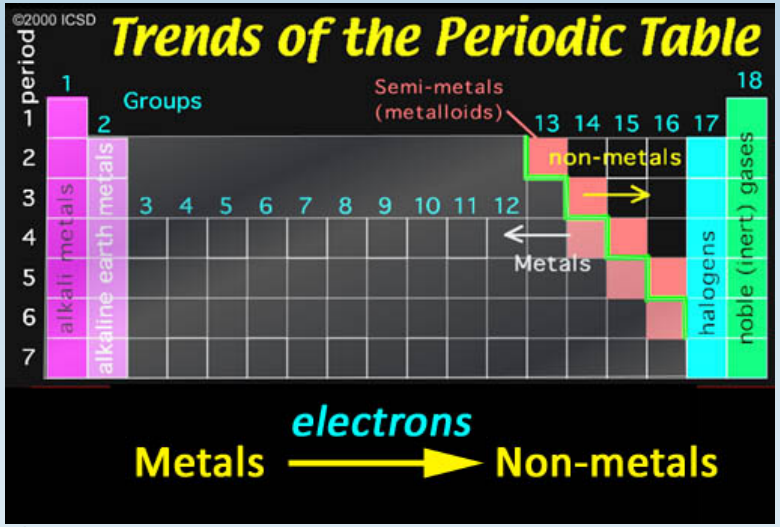
Metals

- Almost **75%** of elements are metals
- Not all of them are shiny like gold and silver!
- What are characteristics of metals?
  - **Good conductors** of electricity (Ag, Cu)
  - **Reactive** (form compounds easily) (Na, K)
  - Solid at room temperature
  - Form **alloys** (combine 2+ metals) (steel, bronze)



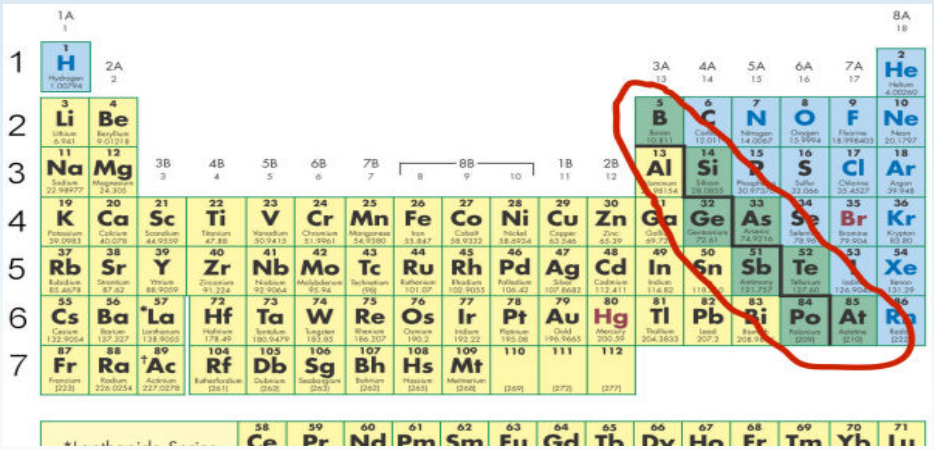
Nonmetals

- Found just above the "staircase" in Groups 4 through 8.
- Not good conductors of electricity or heat.
- Found only as a gas or solid at room temperature.
- Examples:
  - Hydrogen, Nitrogen, Oxygen, Sulfur, etc.

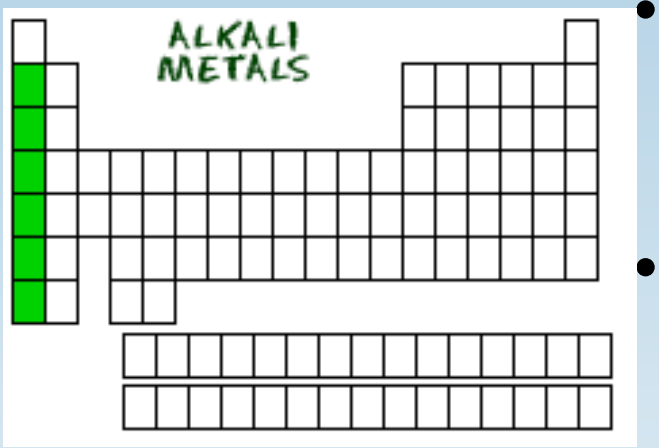


Metalloids

- Found along the “staircase” on the Periodic Table.
- Share properties of both metals and nonmetals.



Family: Alkali Metals



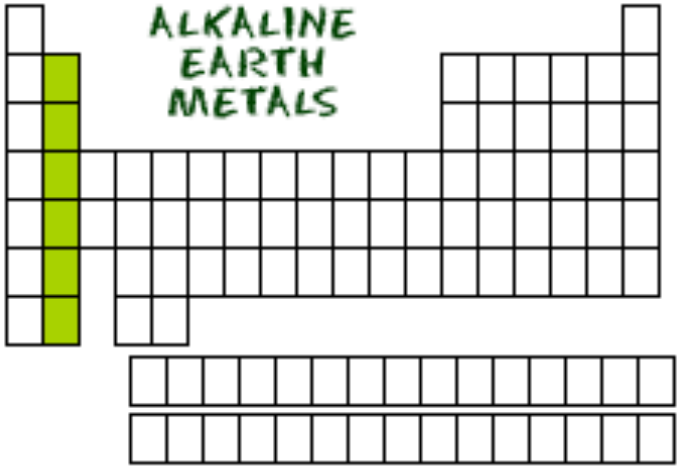
- Notice that **Hydrogen is NOT** part of this family. It's in group 1, but it's NOT an alkali metal
- Family Members:
  - Lithium **(Li),** Sodium **(Na),** Potassium **(K),** Rubidium **(Rb),** Cesium **(Cs)** and Francium **(Fr).**

- These are VERY **reactive** because they have one electron in their outer shell.
  - That's one away from having a full shell. When you are that close to having a full shell, you **want to bond with other elements** and lose that electron.
  - **Increased desire to bond = greater reactivity**

Family: Alkaline Earth Metals

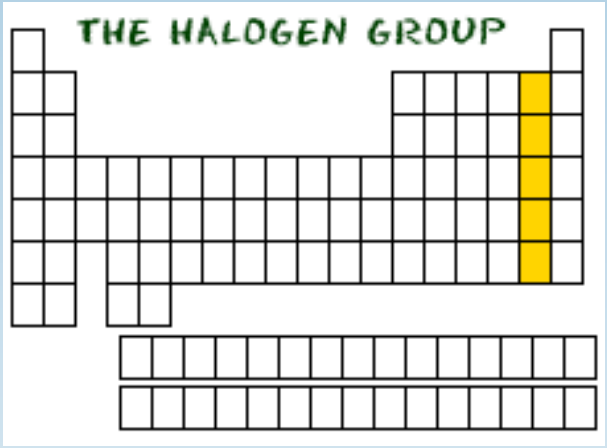
- They live in **group 2**
- Family Members:

  Beryllium **(Be),** Magnesium **(Mg),** Calcium **(Ca),** Strontium **(Sr),** Barium **(Ba),** and Radium **(Ra).**



- **Second most reactive** group on the table (alkali metals are first)
- They have two electrons in their outer shell that they want to give up to have a full shell

Family: Halogens



- They live in the second column from the right
- Halo= salt, gen = maker
- Family members:

  Fluorine **(F),** Chlorine **(Cl),** Bromine **(Br),** Iodine **(I),** and Astatine **(At).**

- Commonality: they are all one electron shy of a full shell.
  - They are so close to being happy with full shells, that they have a tendency to **bond** with many different elements to form **compounds** (typically salts)
  - That means that they are **reactive**

Family: Noble (Inert) Gases

- Located on the far right column
- Family Members:
  - Helium **(He),** Neon **(Ne),** Argon **(Ar),** Krypton **(Kr),** Xenon **(Xe),** and Radon **(Rn)**
- They are the **most stable** of all (don't react with much) because they have **full shells**
  - They don't want to give up or take any more electrons than they already have
- Glow when given electricity