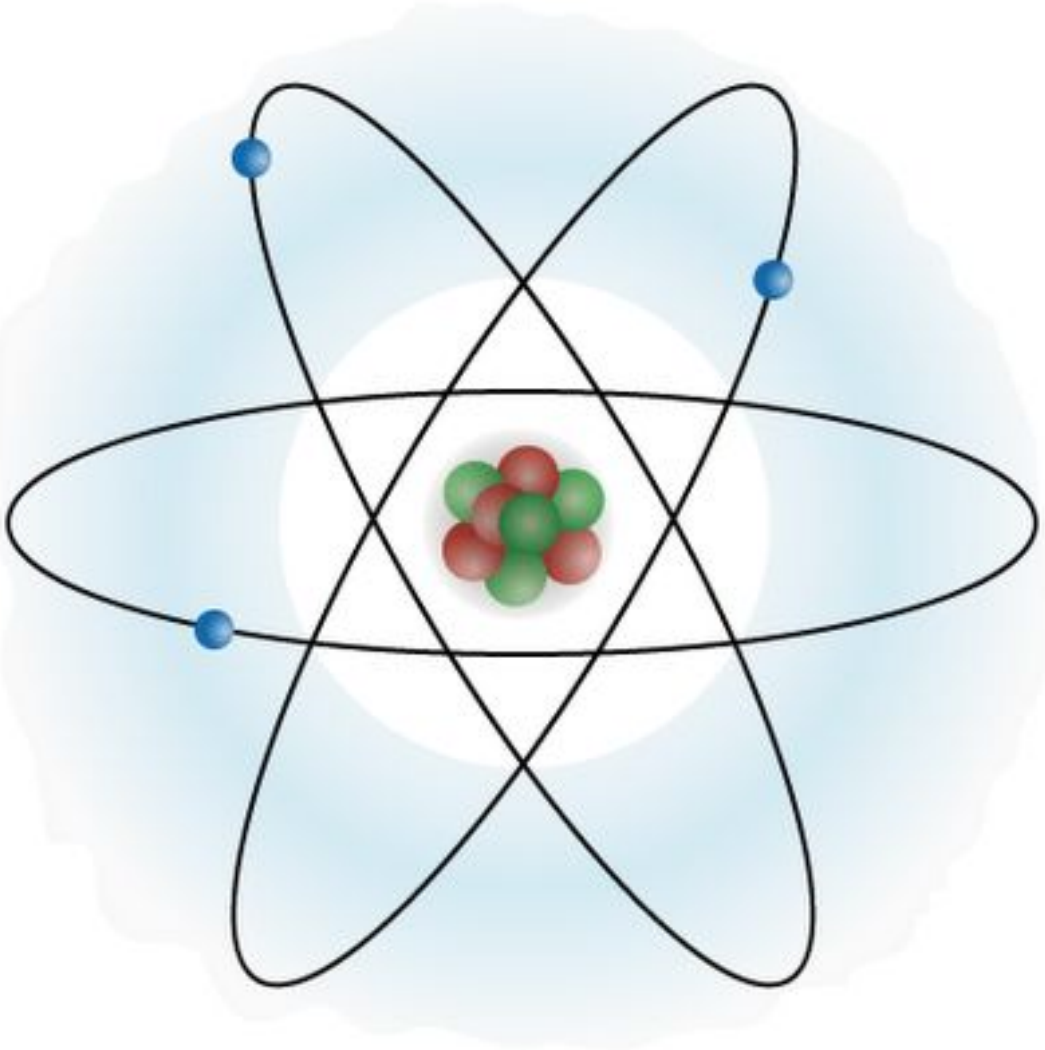
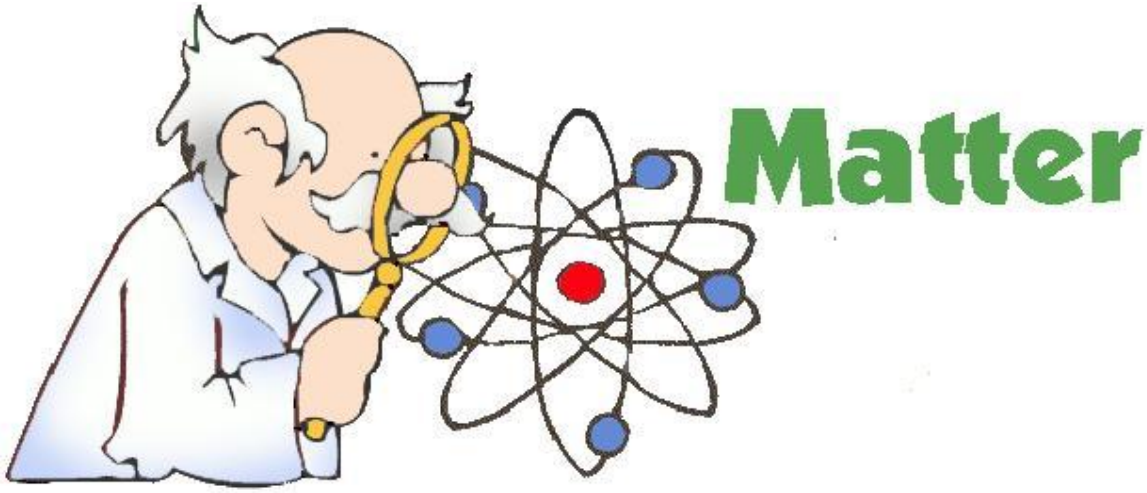
The Structure of Atoms



The Basic Building Block of Matter

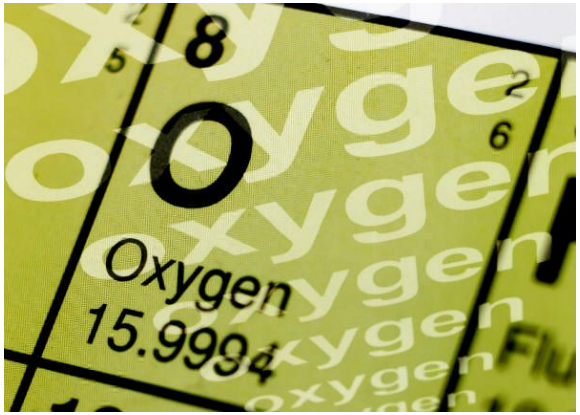
The Particle Theory of Matter

- Matter is made of particles that are in constant motion
- Every kind of matter is made of one or more elements
- Atoms are the smallest particle of an element



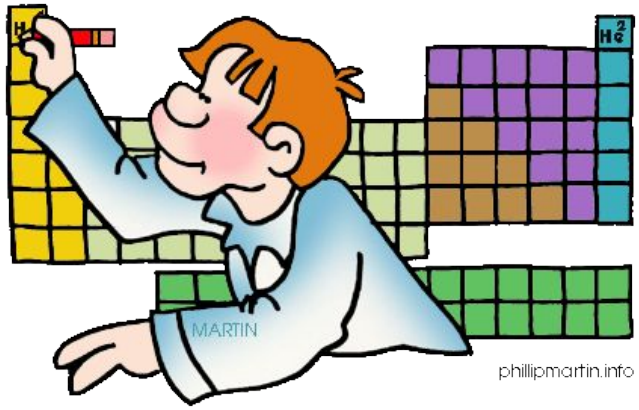
Elements

- Elements are the building blocks of all matter



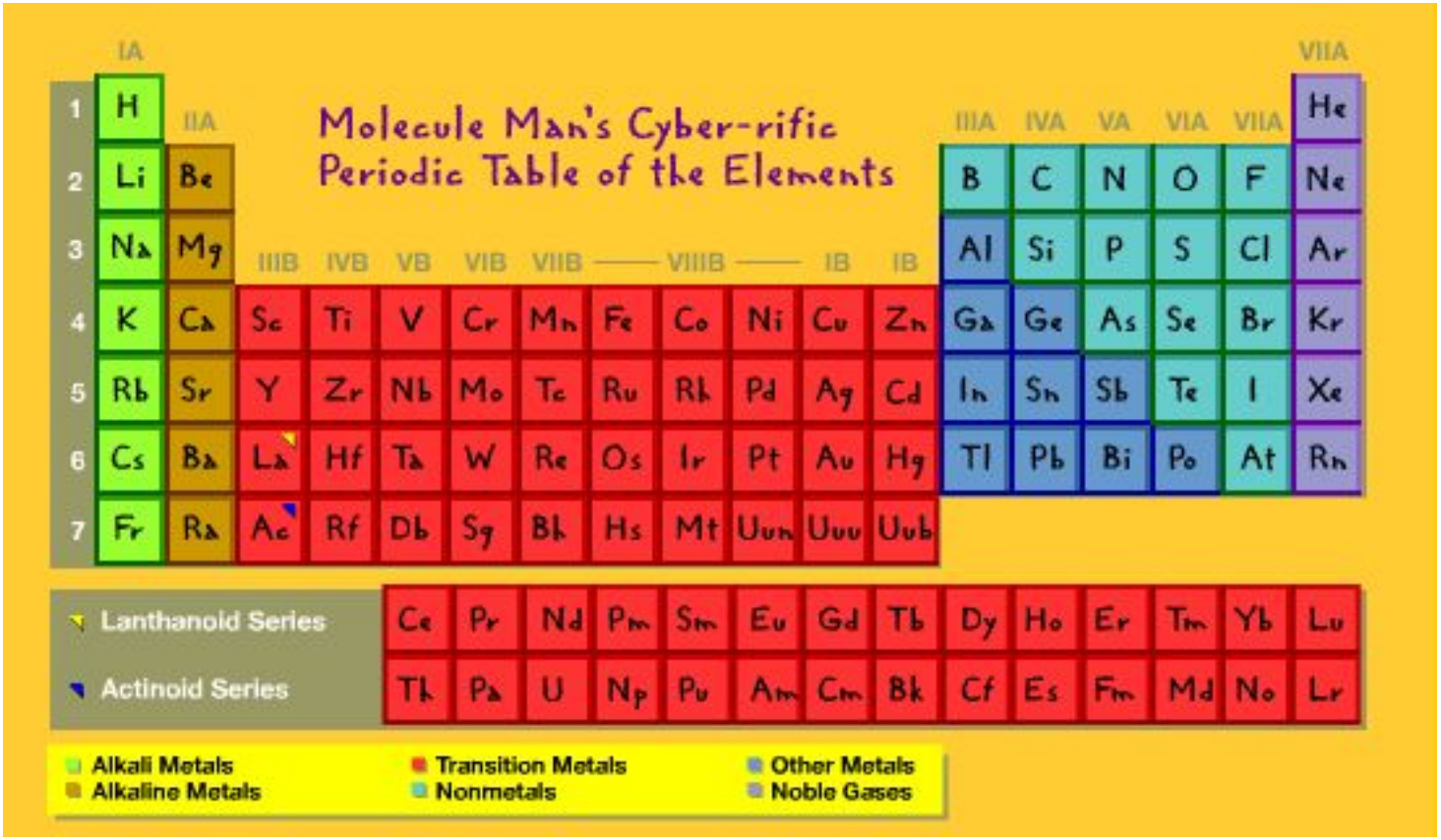
- The periodic table is a list of all of the elements that can build matter

- It's a little like the alphabet of chemistry



Elements

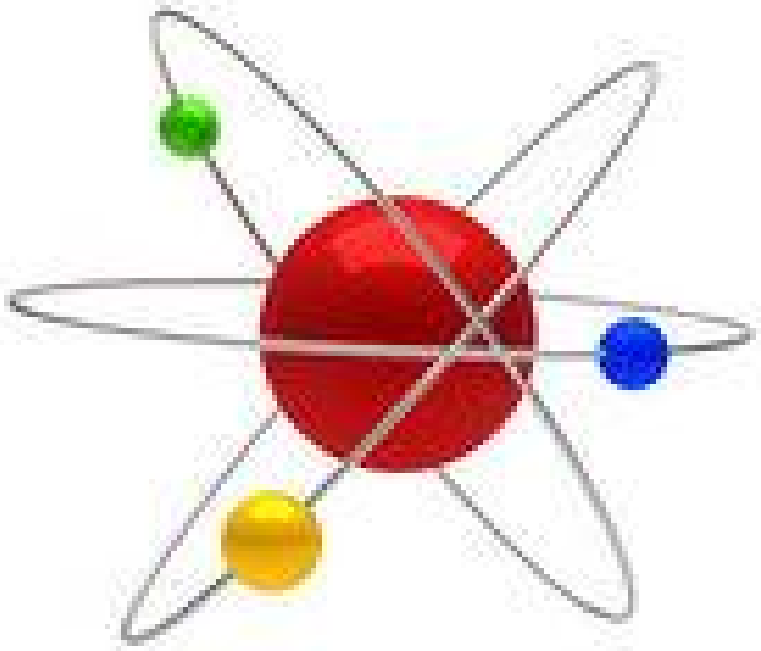
There are currently 118 elements that have been identified though only 88 of them are naturally occurring.



So What are Elements?

- Elements are made of atoms
- While the atoms may have different weights and organization, they are all built in the same way

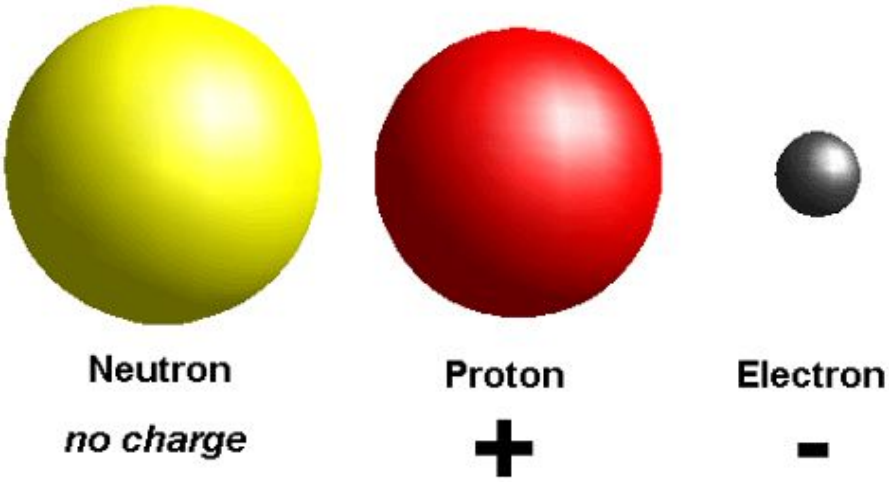
A Quick Review of the Structure of Atoms

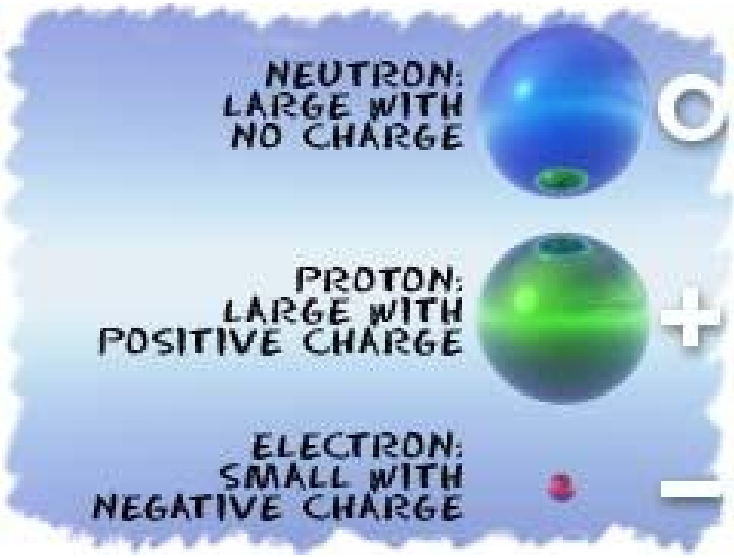


Subatomic Particles

There are three basic parts of an atom:

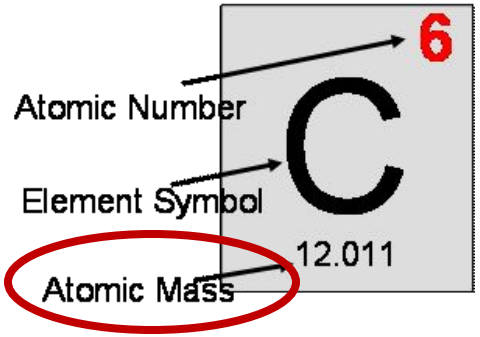
- **Protons** = positive charge
- **Neutrons** = no charge
- **Electrons** = negative charge



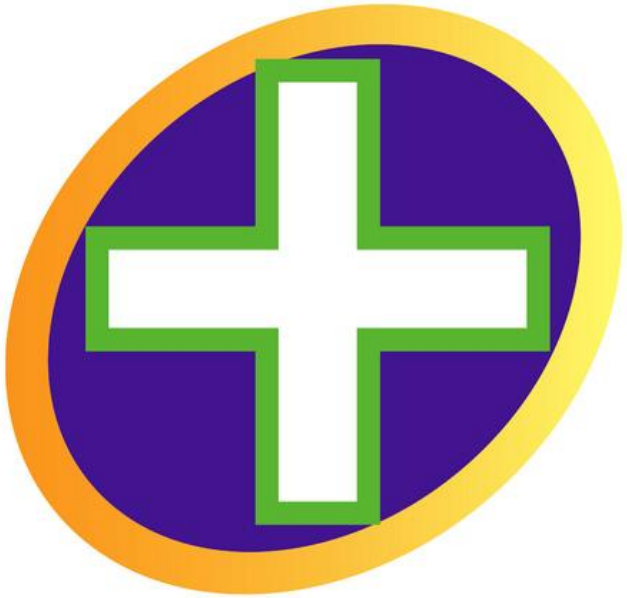


Atomic Mass Unit (AMU)

- this is the protons, neutrons, and electrons of the atoms of that element
- the mass of the proton and neutron are about the same, **but** the mass of the electron is much smaller (about 1/2000 the mass of the proton or neutron) – so the majority of the atomic mass is contributed by the protons and neutrons
- usually the number of electrons in an atom of that element equals the number of protons in the nucleus. This is not the case for neutrons



PROTON

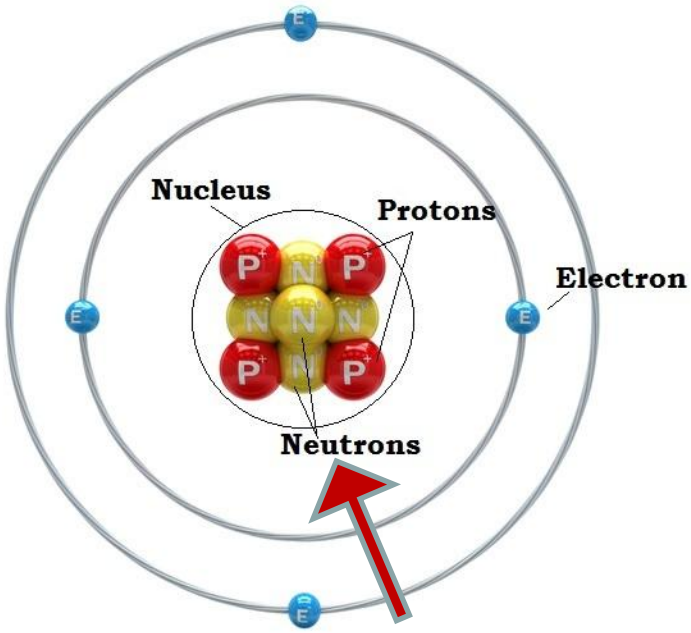


- positively charged atomic particle (+)
- located in the nucleus of the atom
- the number of protons in an atom's nucleus is also the atomic number
- the weight of 1 proton is 1 AMU

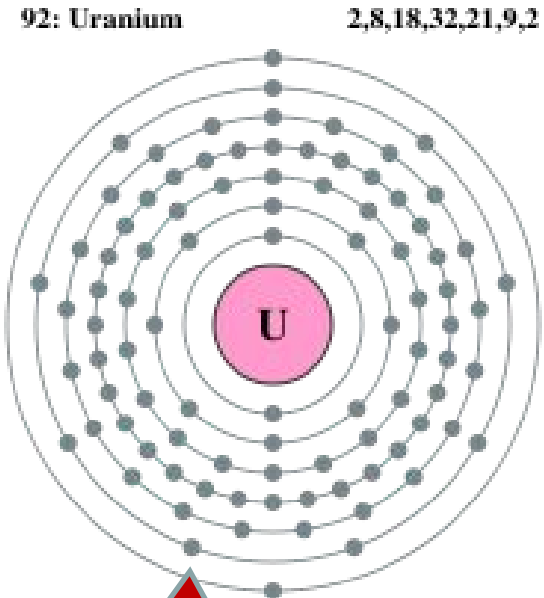
Remember …. Atomic Mass Unit (AMU) is used to indicate mass on an atomic scale

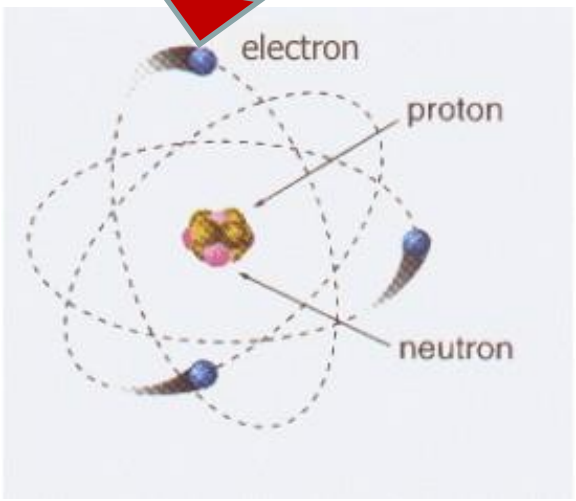
Neutron

Not this neutron....



- neutrally charged atomic particle (no charge)
- located in the nucleus of the atom
- the weight of one neutron is 1 AMU
- for the atoms of the first 20 elements, the number of neutrons is either equal to or slightly greater than the number of protons





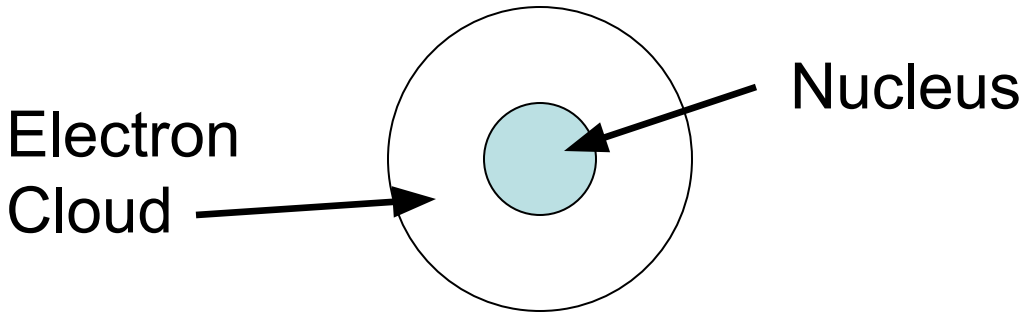
Electron

- negatively charged atomic particle (-)
- located **outside** the nucleus of the atom in **energy levels or energy shells**
- the number of electrons surrounding an atom's nucleus is generally equal to the number of protons
- have almost **no weight** (1/1836 the size of a proton) – so electrons are not counted when weighing an atom

Atomic Structure

There are two regions on an atom:

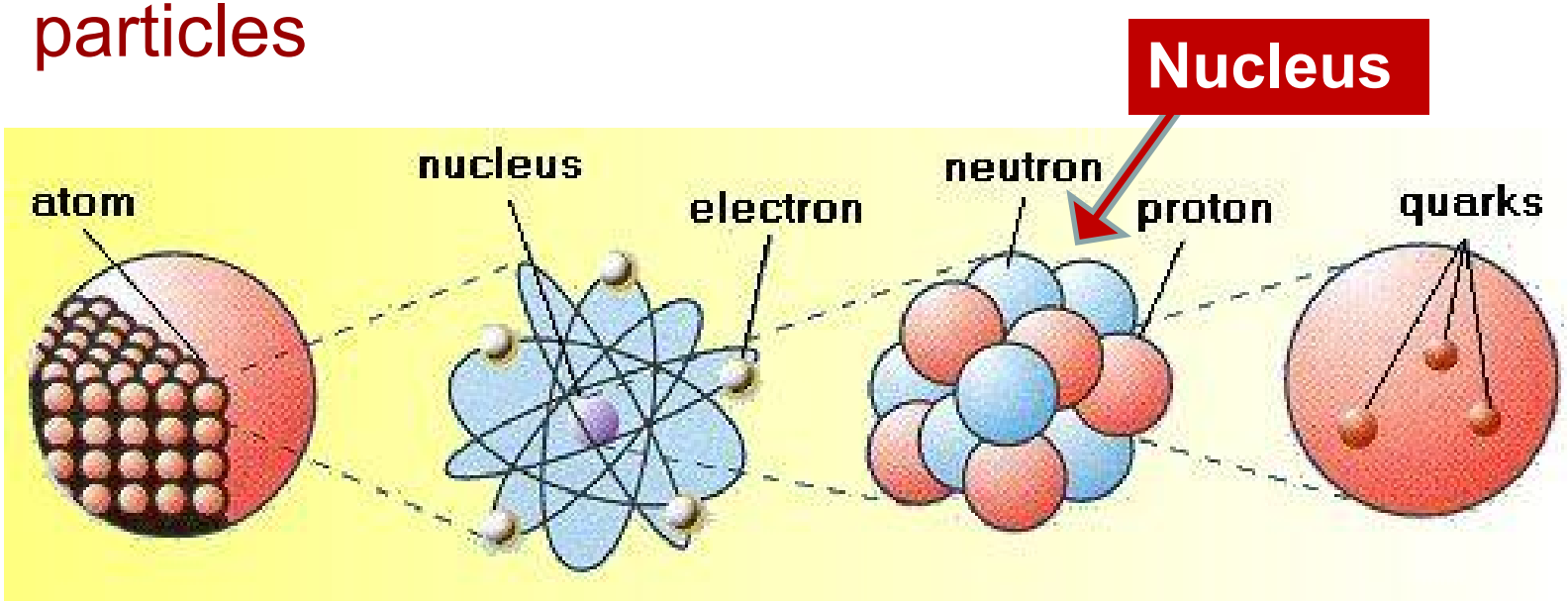
1) **Nucleus**: the center of the atom that contains the mass of the atom
2) **Electron cloud**: region that surrounds the nucleus that contains most of the space in the atom



What's in the Nucleus?

The nucleus contains 2 of the 3 subatomic particles:

- **Protons**: **positively** charged subatomic particles
- **Neutrons**: **neutrally** charged subatomic particles

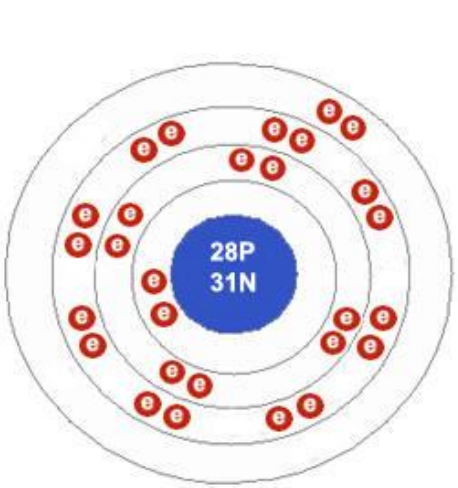


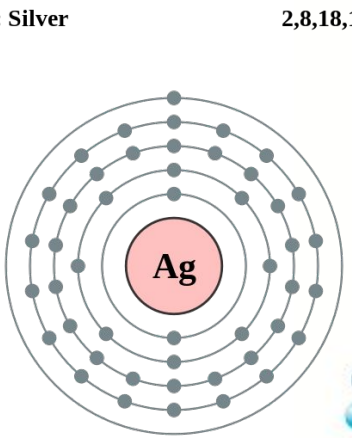
What's in the Electron Cloud?

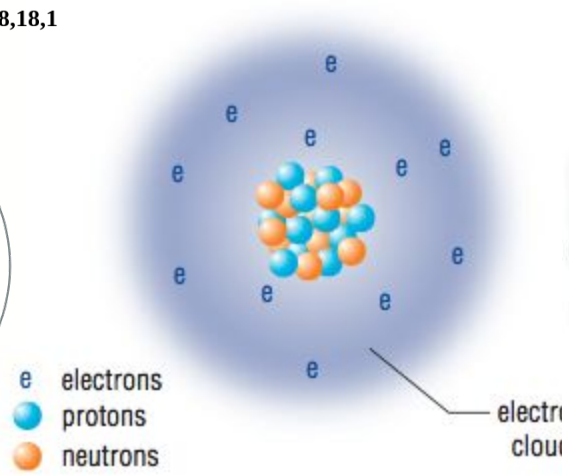
The 3rd subatomic particle is found in a cloud that surrounds the nucleus of an atom

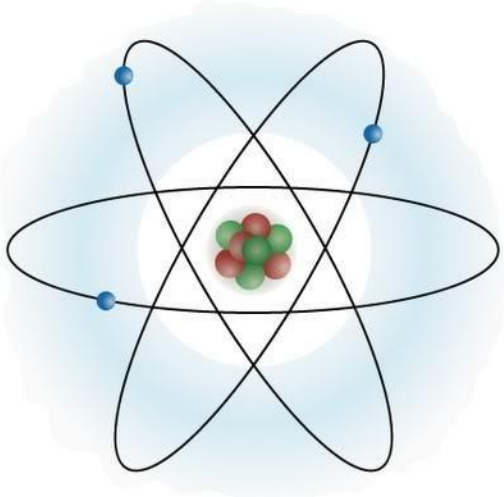
- **Electron**: the subatomic particle with a **negative** charge and relatively no mass

There are many ways electron clouds are illustrated





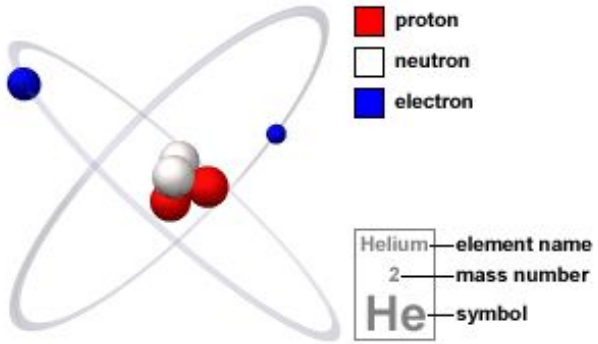


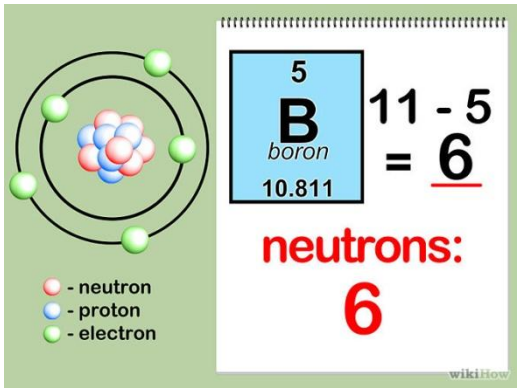


Do Subatomic Particles Balance Each Other?

In general, we find that within an atom ……

- number of protons = number of electrons
- if 20 protons are present in an atom, then 20 electrons are there to balance the overall charge of the atom — **this atoms is said to be neutral**
- neutrons have no charge; therefore they do not have to equal the number of protons or electrons

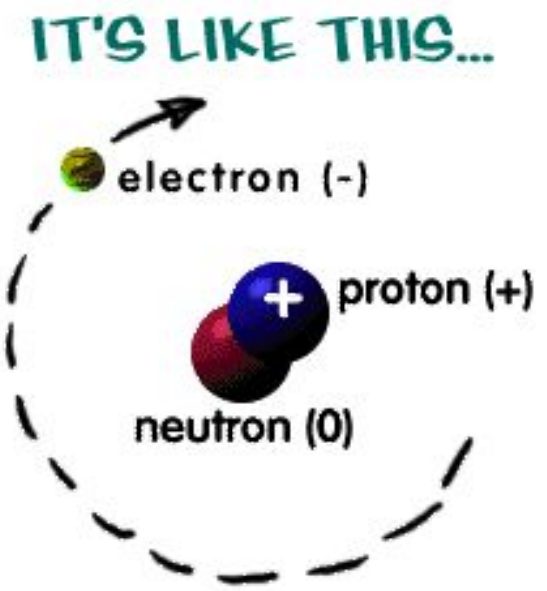




How do these particles interact?

- Protons and neutrons live compacted in the tiny positively charged nucleus accounting for most of the mass of the atom

- The negatively charged electrons are small and have a relatively small mass but occupy a large volume of space outside the nucleus



Who am I?

I don't mean to be negative all the time, but, well, I'm always on the go. Who am I?

ELECTRON

Me? I stay positive. It's the only way I know how to be. Who am I?

PROTON

I have almost no mass- no weight to throw around. And just once I'd like to be at the center of things. Who am I?

ELECTRON

I stay neutral on most nuclear issues. Who am I?

NEUTRON

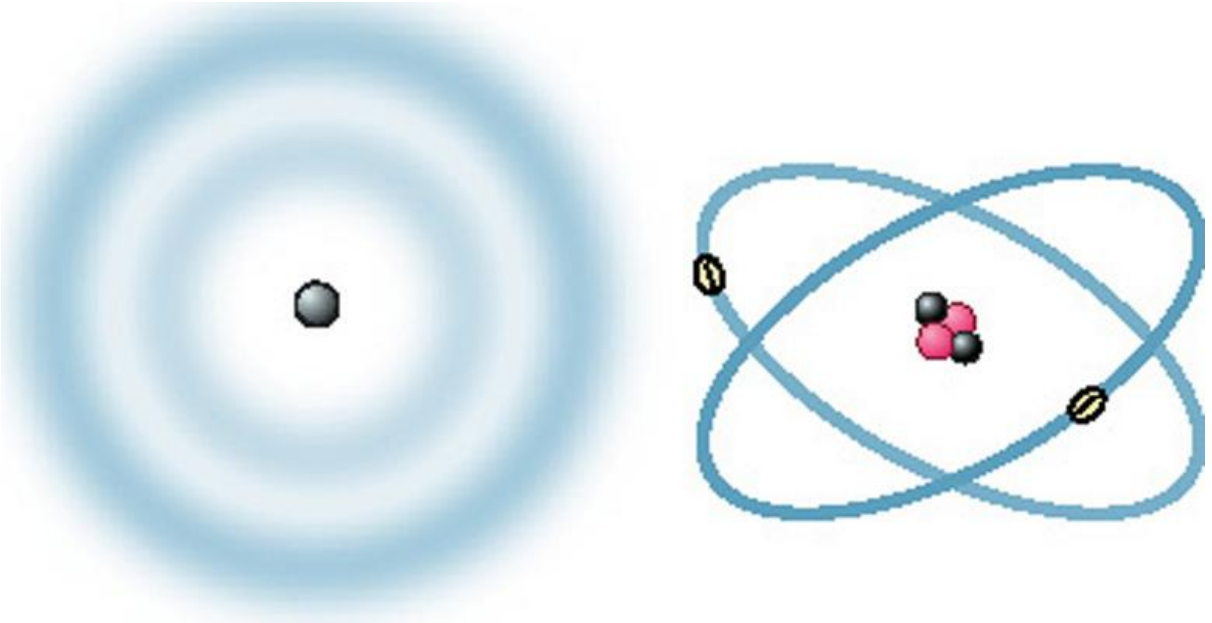
Atoms: The Space Between

Protons and Electrons have opposite charges, but an atom is neutral because it contains equal numbers of protons and electrons

Models of Atoms

Scientists have worked on models of atoms for centuries to understand why matter behaves a certain way

- As we learn more, models change

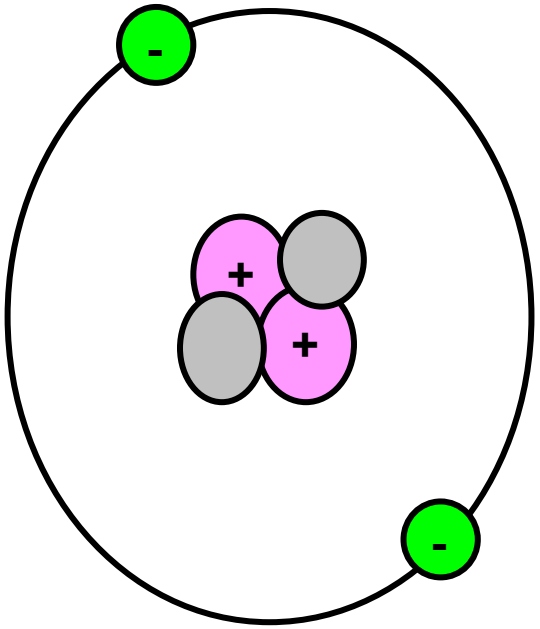


Neils Bohr

- In 1913, Bohr proposed a theory about the structure of the atom based on Rutherford's theory
- Rutherford believed that the atom consisted of a positively charged nucleus, with negatively charged electrons in orbit around it
- Bohr expanded upon this theory by proposing that electrons travel only in certain successively larger orbits.
    - He said that the outer orbits could hold more electrons than the inner ones, and that these outer orbits determine the atom's chemical properties

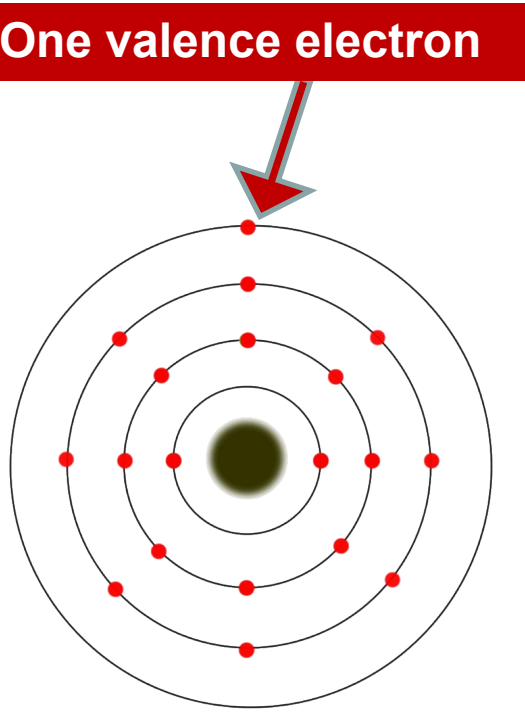
Bohr Model

- The Bohr Model shows all of the particles in the atom.
- Located in the center are circles. Each circle represents a single neutron or proton. Protons should have a plus or **"P"** written on them. Neutrons should be blank or have an **"N"**.
- In a circle around the nucleus are the electrons. Electrons should have a minus sign or an ***"e"***.



Electrons Have Special Rules…

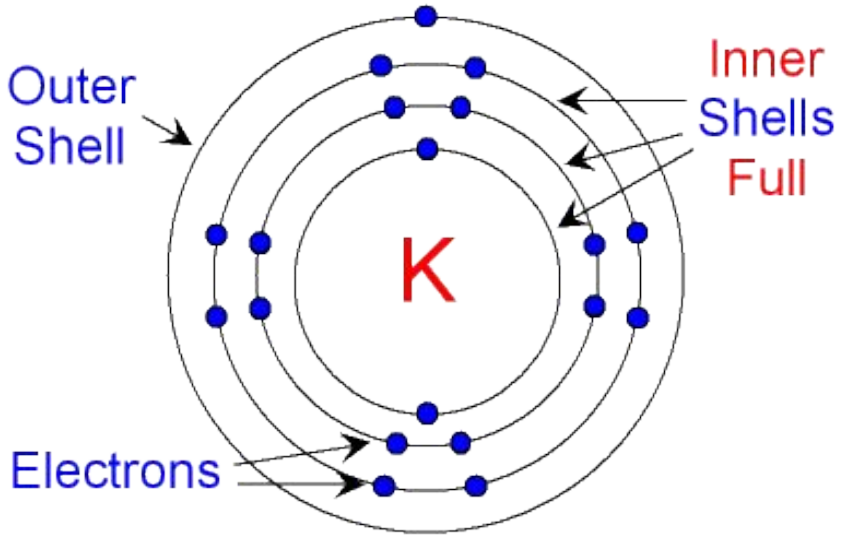
- You can't just shove all of the electrons into the first orbit of an electron shell
- Electrons live in something called **shells or energy levels**
- Only so many can be in any certain shell
- The electrons in the outermost shell of any element are called **valence electrons**



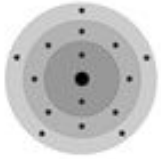
Electron Locations in Atoms

Electrons are arranged in Energy Levels or Shells around the nucleus of an atom.

- first shell → a maximum of **2** electrons
- second shell → a maximum of **8** electrons
- third shell → a maximum of **8** electrons



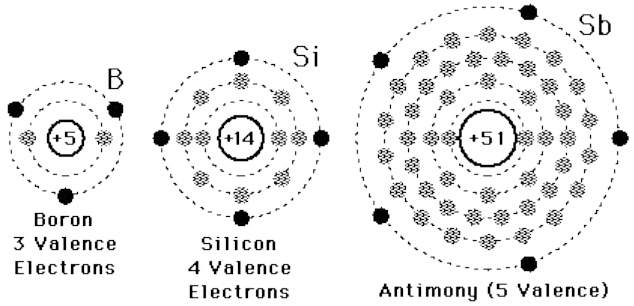
ENERGY LEVELS
ELEMENTS 1–20

HYDROGEN 1  1.01							HELIUM 2  4.00
LITHIUM 3  6.94	BERYLLIUM 4  9.01	BORON 5  10.81	CARBON 6  12.01	NITROGEN 7  14.01	OXYGEN 8  16.00	FLUORINE 9  19.00	NEON 10  20.18
SODIUM 11  22.99	MAGNESIUM 12  24.31	ALUMINUM 13  26.98	SILICON 14  28.09	PHOSPHORUS 15  30.97	SULFUR 16  32.07	CHLORINE 17  35.45	ARGON 18  39.95
POTASSIUM 19  39.10	CALCIUM 20  40.08						

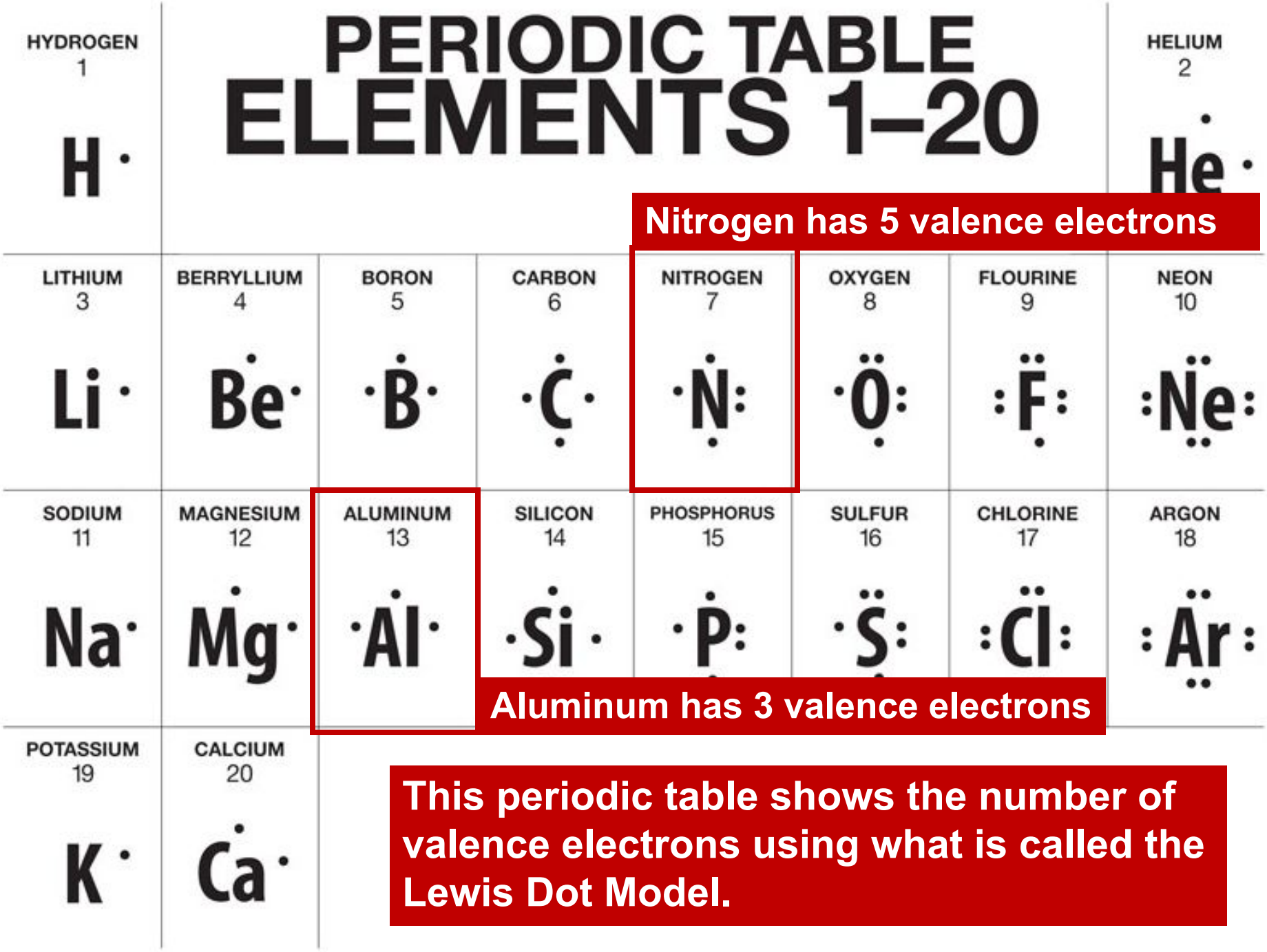
Valence Electrons

These are electrons found in the outermost energy shell (furthest away from the nucleus)

- are important because they interact with other atoms
- responsible for many of the characteristic properties of the atom
- affect the way an atom bonds
- atoms can have anywhere between 1 and 8 valence electrons



PERIODIC TABLE
ELEMENTS 1–20



Nitrogen has 5 valence electrons

Aluminum has 3 valence electrons

This periodic table shows the number of valence electrons using what is called the Lewis Dot Model.

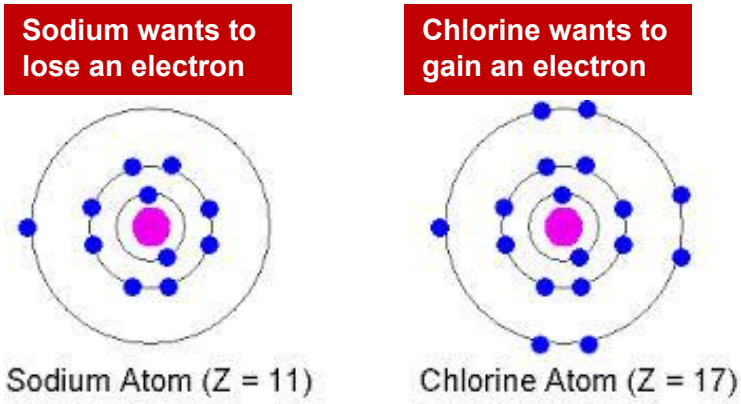
The Rule of 8

All atoms want to have a full valence shell (8 electrons)

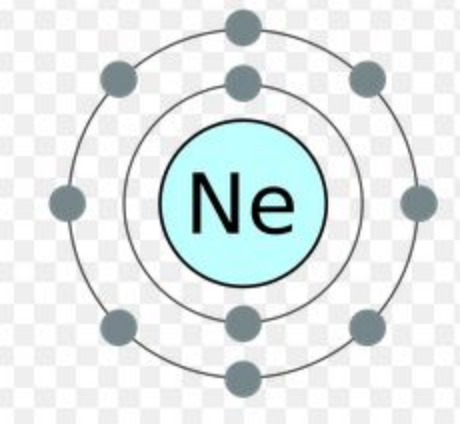
- This makes them happy atoms that will not react with other atoms.

Atoms with less than 8 electrons in their valence shell will react chemically (bond) with other atoms in one of 2 ways:

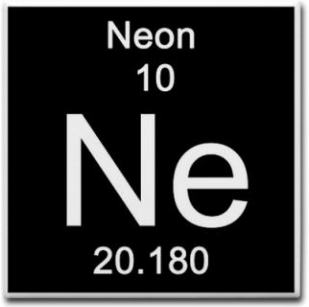
- gain electrons to equal 8
- lose their valence electrons



In general, the fewer the electrons that need to be gained or lost, the more likely the atom will react



See if you can find the following for Neon



5 Protons + 5 Neutrons

Contains protons & neutrons

2 Electrons

Can hold up to 2 electrons

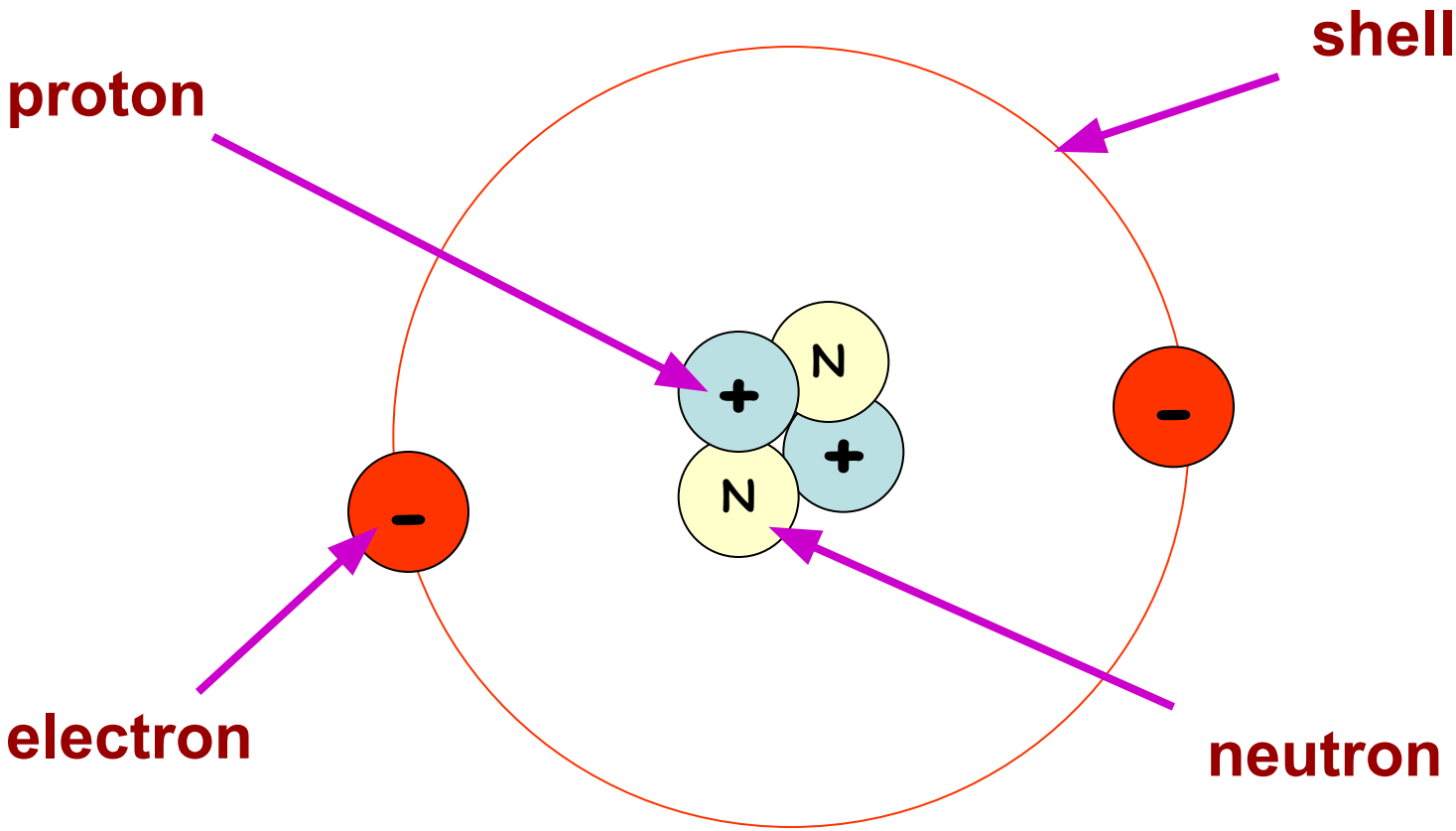
8 Electrons

Can hold up to 8 electrons

no electrons

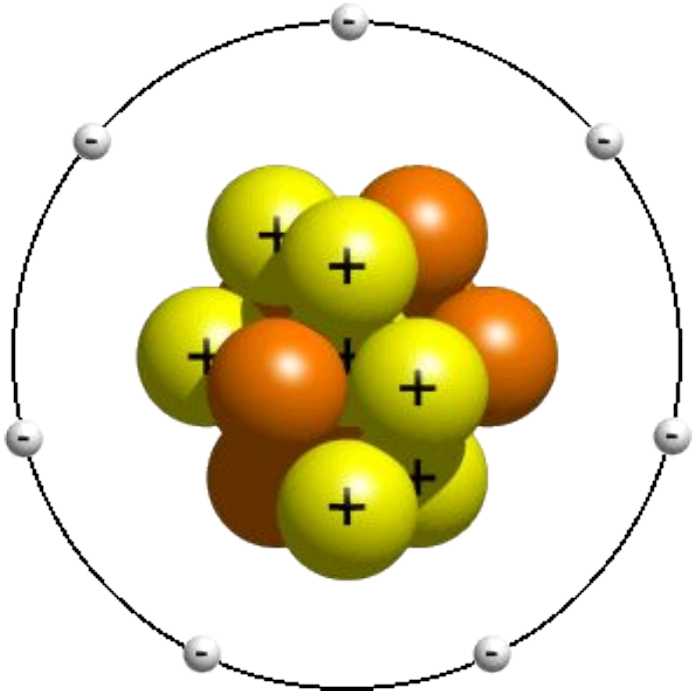
Can hold up to 8 electrons

Name the Subatomic Particles of an Helium Atom



Limitations of Bohr Model

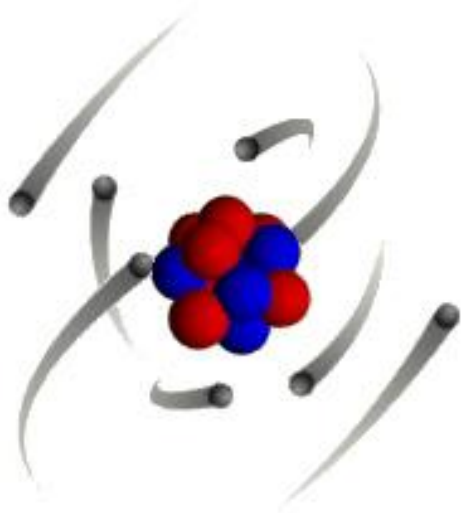
- electrons do not orbit the nucleus of an atom like planets orbit the Sun
- the scale does not represent the actual size of an atom

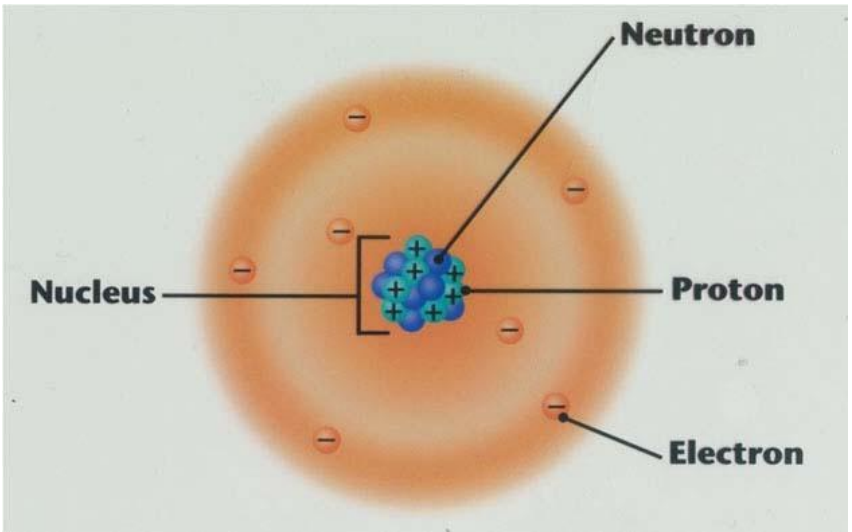


Even with these limitations, the Bohr Model is widely used because of its ease in helping to understand the basic parts and locations of particles within an atom

Electron Cloud Model

- current model in use
- shows the electrons as forming a negatively charged cloud around the nucleus
- it's impossible to determine exactly where an electron is at any given time





SUMMARY

1. The **Atomic Number** of an atom = number of protons in the nucleus.
2. The **Atomic Mass** of an atom = number of Protons + Neutrons in the nucleus.
3. The number of Protons = Number of Electrons.
4. Electrons orbit the nucleus in **shells**.
5. Each shell can only carry a set number of electrons.

Atomic Number

Atomic Mass
(# protons + # neutrons)