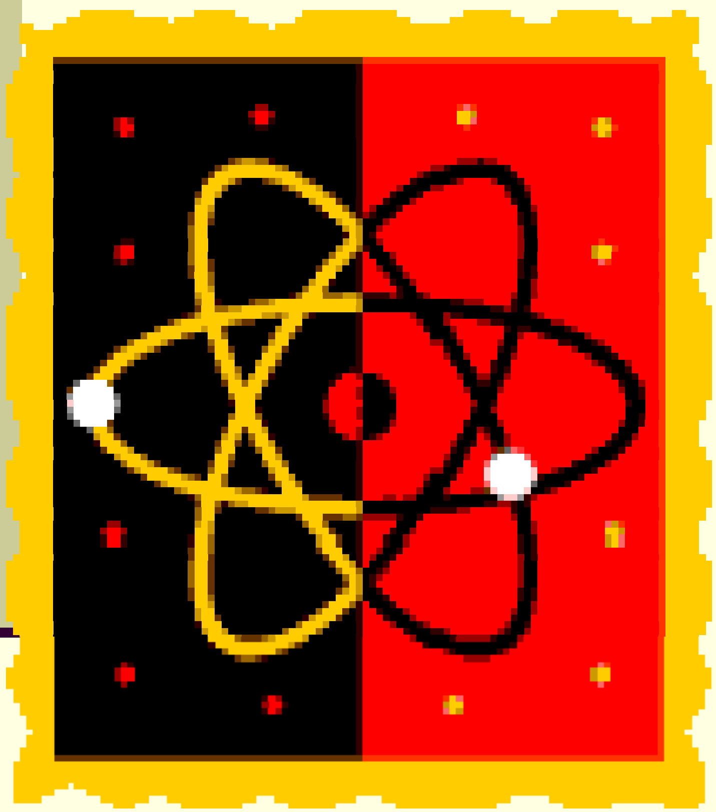
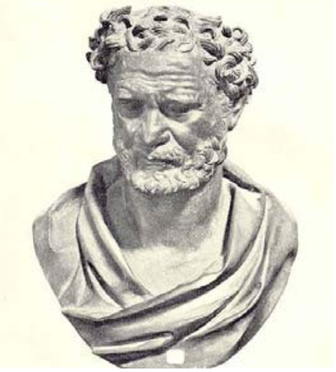
Chapter 5



Atoms: The Building Blocks of Matter

Atomic Models – How Humans Developed Modern Atomic Theory…

- Democritus- Ancient Greek
  - Matter cannot be divided into smaller and smaller pieces forever, eventually the smallest piece will be obtained
  - Democritus named this "smallest piece" - the atom

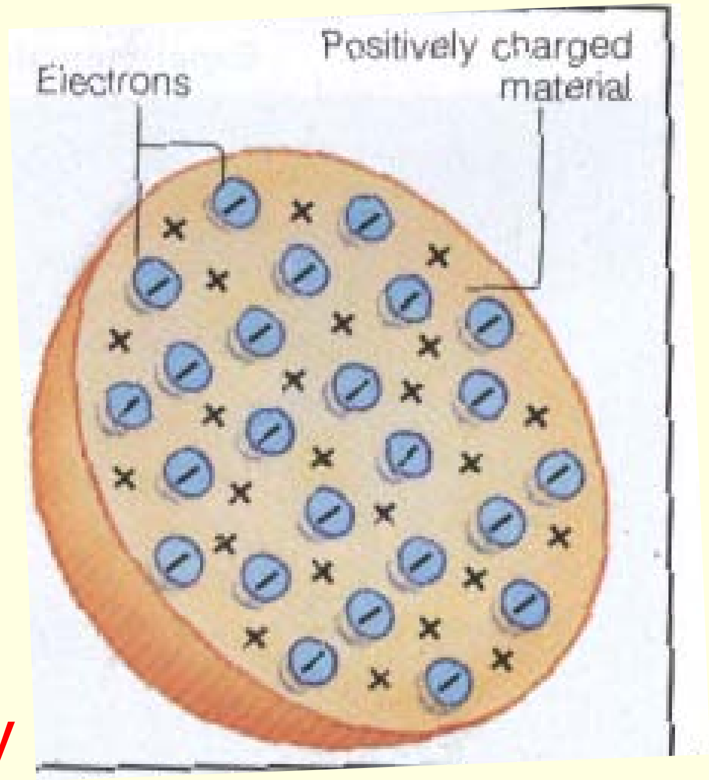


Atomic Models – How Humans Developed Modern Atomic Theory…

- Dalton- English Chemist from the Early 1800s
  - all elements are made of atoms
  - atoms of the same element are exactly alike
    - ex. 1 atom of Fe is exactly like all other atoms of Fe
  - atoms of different elements are different
    - Ex: Any atom of Fe is different from an atom of Au
  - compounds are formed by joining 2 or more atoms
    - Na + Cl --> NaCl

Atomic Models – How Humans Developed Modern Atomic Theory…

- Thomson - English Chemist - late 1800s
- "Plum Pudding" Model
  - An atom is made of a pudding like positively charged matter with negatively charged particles scattered throughout.
  - Discovered the negatively charged matter.

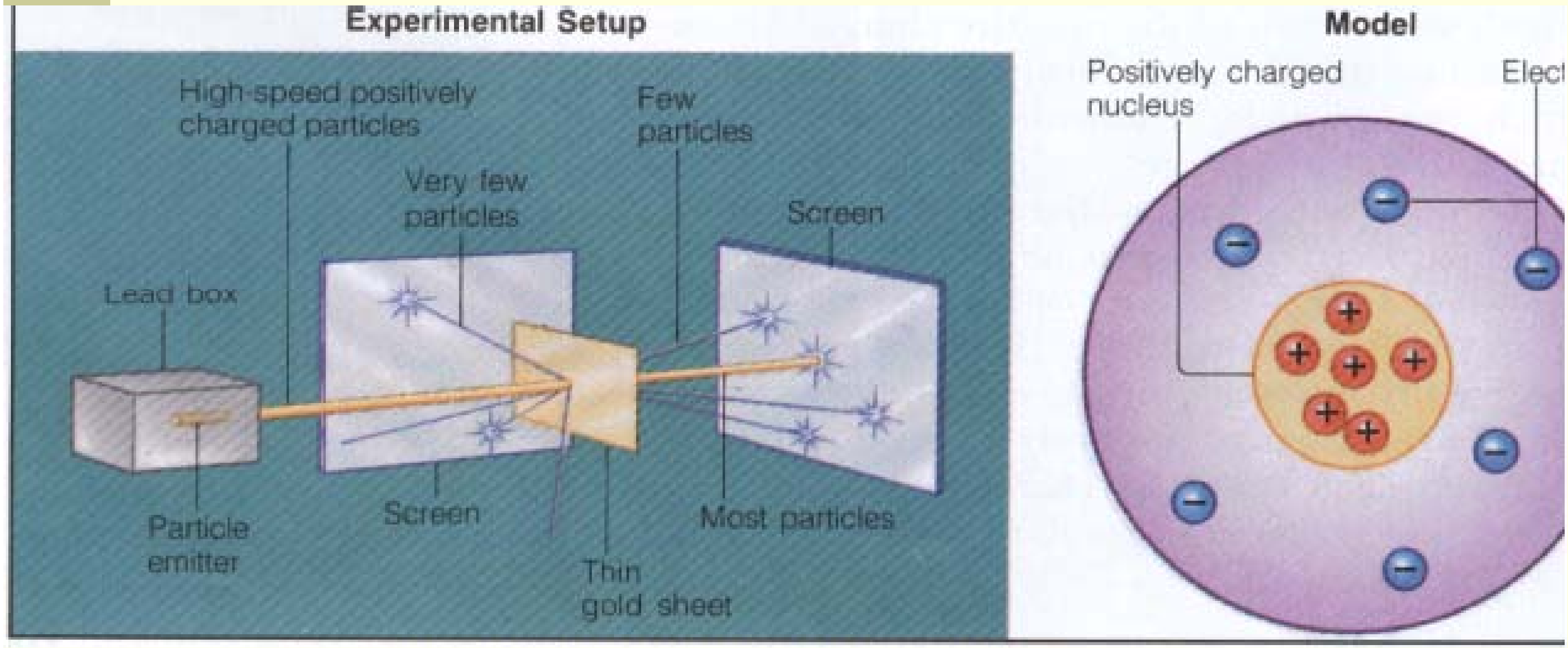


Atomic Models – How Humans Developed Modern Atomic Theory.

- Rutherford - British Physicist - 1911
  - Gold Foil experiment - shooting tiny particles at gold foil proved that most of the atom is empty space because most of the particles went through the foil, but some of the atom is a dense positively charged area that he called the nucleus
  - Named the Nucleus- Center of the atom that contains all of the atoms positively charged particles
  - All the electrons (negatively charged particles) are scattered outside the nucleus

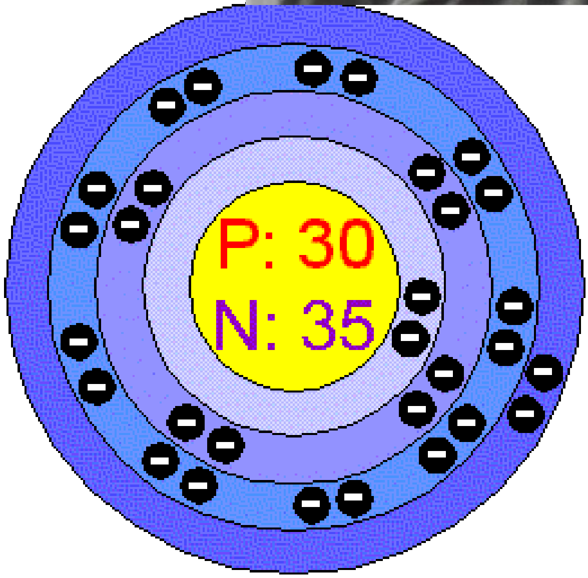
Atomic Models – How Humans Developed Modern Atomic Theory…

- Rutherford's Model



Atomic Models – How Humans Developed Modern Atomic Theory…

- Bohr 1913 Danish scientist
  - Each electron does not swarm around the nucleus randomly, rather electrons move in definite orbits around the nucleus
  - These orbits are located at specific distances from the nucleus
  - These orbits are called energy levels

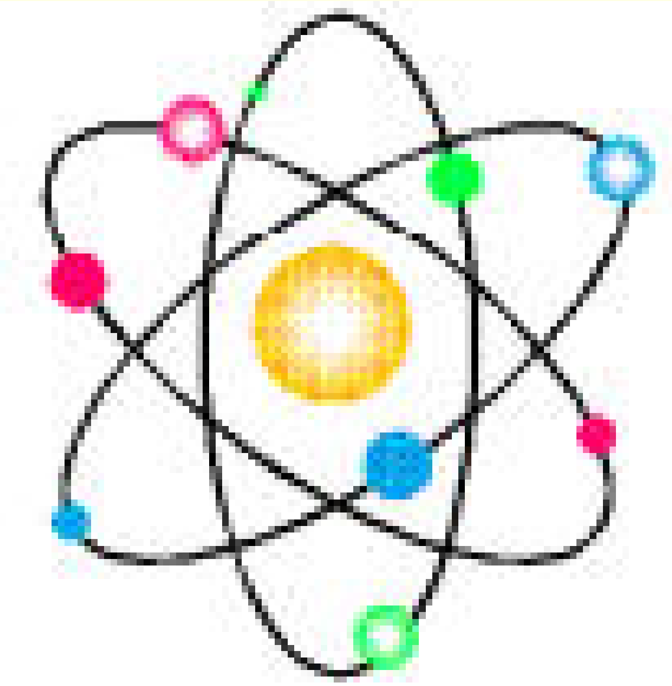


Atomic Models – How Humans Developed Modern Atomic Theory…

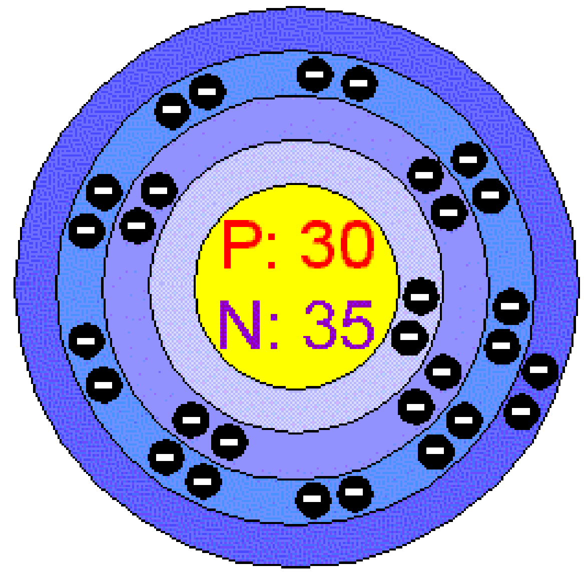
- Wave Model-
  - electrons do not move around the atom in a designated path
  - the exact location of an electron cannot be known
  - scientists can only predict the location of an electron based on how much energy the electron has

Atomic Models – How Humans Developed Modern Atomic Theory…

- Modern Atomic Theory States…
- An atom has a small positively charged nucleus
- This nucleus is surrounded by a large region in which there are enough electrons to make the atom neutral
  - Neutral means not + or – charged

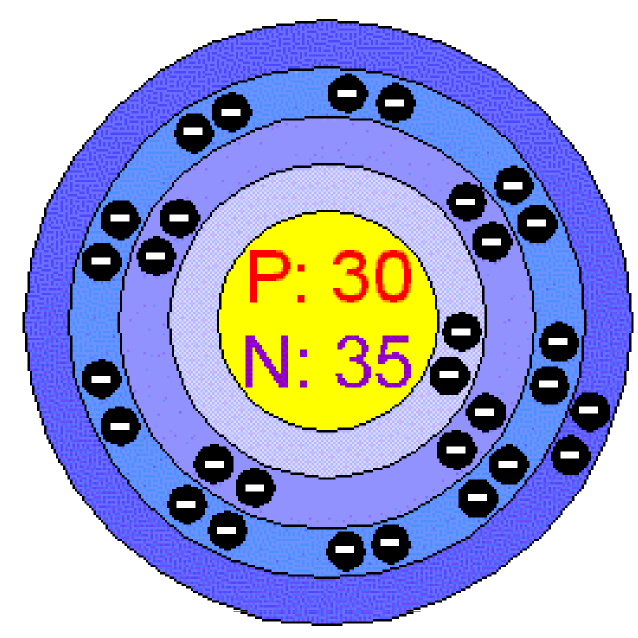


Atomic Structure – How is an Atom Arranged?



- The atom is made up of a nucleus and surrounding negatively charged particles – called electrons
- The nucleus is extremely small compared to the size of the entire atom (nucleus and surrounding electrons)
  - It has been compared to a bee on the 50 yard line (nucleus) relative to a football stadium (entire atom)!

Atomic Structure – How is an Atom Arranged?



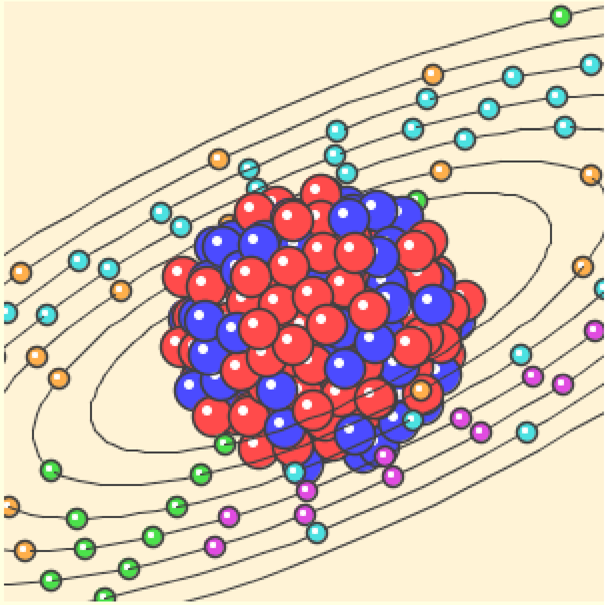
- The nucleus contains BOTH protons & neutrons
- Proton
  - has a mass of 1 amu
  - positively charged
  - located in the nucleus
- Neutron
  - has a mass of 1 amu
  - neutral charge
  - located in the nucleus

amu = atomic mass unit

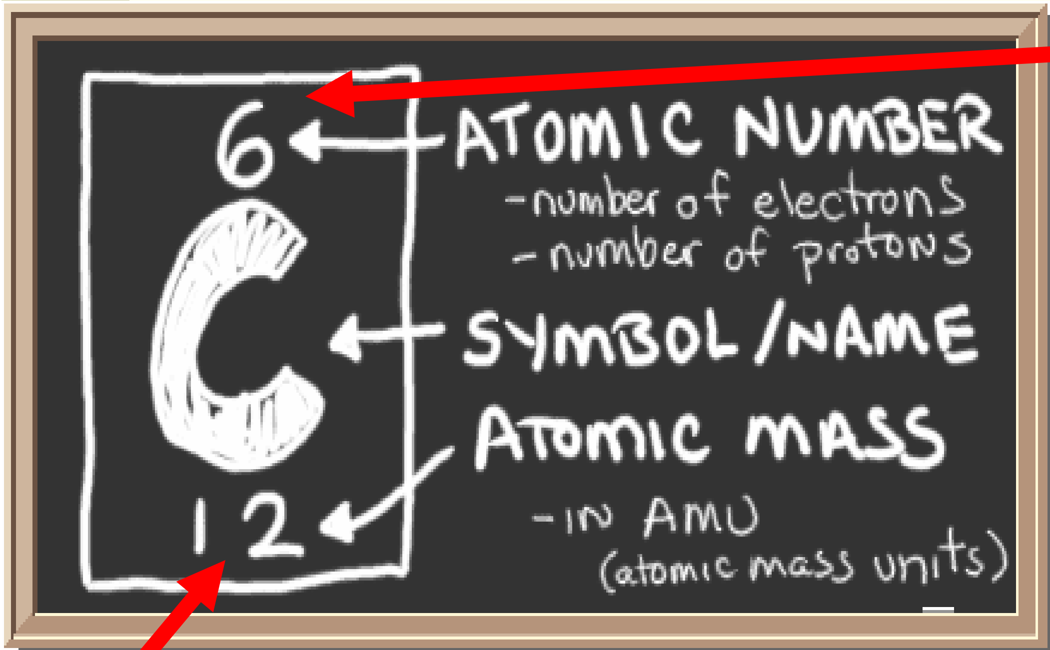
Atomic masses are so small, scientists created a unit of mass specifically for atoms!

Atomic Structure – How is an Atom Arranged?

- Nucleus- positively charged, has most of the atoms mass
  - Proton – positively charged particle, mass is 1 atomic mass unit (1 amu)
  - Neutron – has no charge (neutral), mass is 1 amu
- Electron shell
  - Electron – negatively charged particle, mass is only 1/1836 of an amu



Atomic Math – Very Important "Rules"



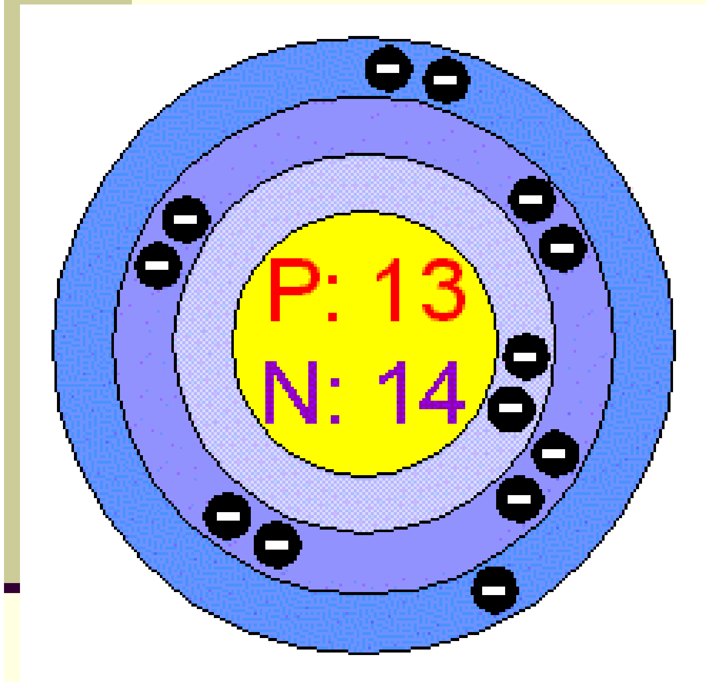
- *Atomic Number = # of Protons*

  (And usually the # of Electrons – we'll talk about what happens when they don't match later…)

Atomic Mass Number = # of Protons + # of Neutrons

Since P's and N's both have about the same mass (1 amu), we must add them together to calculate the mass of the atom…

Atomic Math



How many protons does this element have?

What is this element's atomic number?

What is the atomic mass number of this element?

How many neutrons does this atom have?

What is the name of this element?

I know where the Protons and Neutrons live, how about those Electrons???

- Electrons whirl around the nucleus in orbits.
- There is not just one path that the electrons travel in.
- There are “shells” surrounding the nucleus that the electrons can fill.
- Each shell can only hold a certain number of electrons.

I know where the Protons and Neutrons live, how about those Electrons???

You know that the positive charge of the proton and the negative charge of the electron attract each other because opposite charges attract.

So, how come the electrons don't go flying into the nucleus like a magnet?

It's because they have energy to keep them away from the nucleus.

The more energy the electron has, the further away from the nucleus it can live…

These are called energy levels.

I know where the Protons and Neutrons live, how about those Electrons???

- Shell 1 (K)
  - has the lowest energy level
  - can hold 2 electrons
- Shell 2 (L)
  - has the second lowest energy level
  - can hold up to 8 electrons
- Shell 3 (M)
  - has a higher energy level
  - can hold up to 18 electrons

(There are more energy levels (N through P), but you won't learn about them until Chemistry…)

I know where the Protons and Neutrons live, how about those Electrons???

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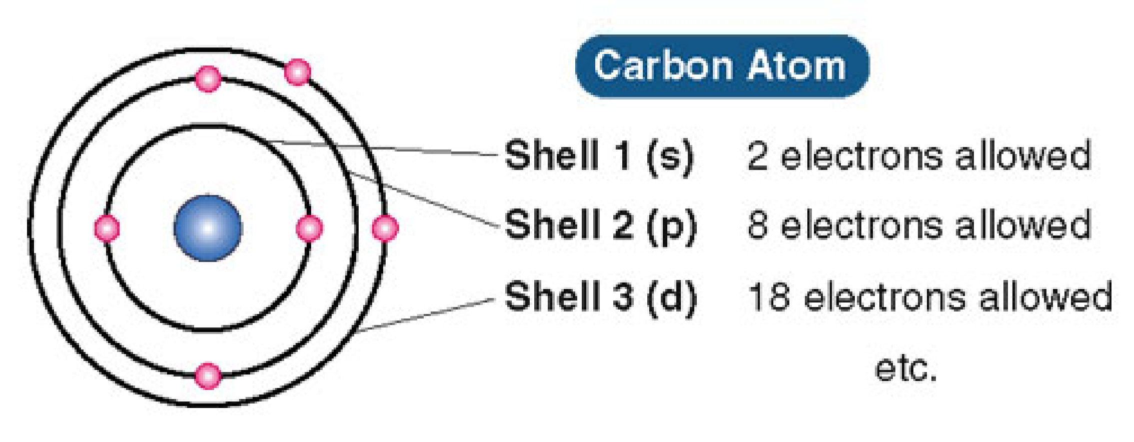

Rebel Atoms – Exceptions to the "Rules"

Isotopes - forms of an atom of an element that have the same number of protons in the nucleus, but a different number of neutrons. They are different "versions" of the same element.

Remember that an atom's identity is determined by the # of protons, so an isotope is still the same element (atomic # = top # in box) but each version has a different atomic mass (bottom # in box)

Ex – Carbon 12: 6 protons and 6 neutrons

Carbon 16: 6 protons and ____ neutrons

Rebel Atoms – Exceptions to the “Rules”

Ions – an atom that is charged because it has unequal number of protons and electrons. So, it has either more positive protons (+ charged) or more negative electrons (- charged)

Ex – all Na atoms have 11 protons, but say an atom has only 10 electrons, it has an extra positive charge (proton), so it’s a “+1 ion”.

Rebel Atoms – Exceptions to the "Rules"

Ions –

What would a +2 chlorine atom's make-up be?

17 protons, 15 electrons

What would a -3 silver be like?

47 protons, 50 electrons

How do the Rebel Isotopes Affect the Atomic Mass of an Element?

As you look at an element in the periodic table, don't you wonder why the atomic masses are those weird decimal numbers? Here's why…

- Atomic mass – average mass of all of the atoms of an element in the universe! This means that is an average of all of the "versions" of the atoms - remember, these are called ISOTOPES!!!
- C can be C-12 or C-14, so C's atomic mass is 12.011 – which is between them.
- But it's not exactly 13 (the average of 12 and 14) because there is MORE of the C-12 version of Carbon than the C-14 version in the universe. So…the average is closer to 12!!!

How do the Rebel Isotopes Affect the Atomic Mass of an Element?

To determine an element's most common form of atom, round it's atomic mass to the nearest whole number.

Ex – C's atomic mass is 12.011 which rounds to 12. Thus, C-12 is the most common form of Carbon.

What is the most common form of Fluorine?

Calculating the Molecular Weight of a Molecule

- Name the atoms
- Count the atoms (using coefficients and subscripts)
- Multiply the number of atoms by the atomic mass (bottom #) of each individual element to find the mass of that particular element in the compound (You will find the atomic mass on the Periodic Table (bottom #))
- Add the mass of each individual element to calculate the total mass of the atom

Let's try a few!!!!

- H_2O
- H_2SO_4
- $CaCO_3$

Forces Within the Atom…

- If opposites attract, and that's what holds the electrons around the nucleus, then how the heck do all of those positive protons stay together in the nucleus??? Don't like charges REPEL each other???
- Well, here is a rundown of the four forces within the Atom…

Forces Within the Atom…

- Electromagnetic force
  - Causes like charges to repel and opposite charges to attract
  - Keeps electrons orbiting the nucleus because they're so attracted to the protons
- Strong force
  - "glues" protons together (ooohhhh, that's how they stick together….)
  - Strongest of all of the forces, but has an extremely limited range (the nucleus)

Forces Within the Atom…

- Weak force
  - Responsible for radioactive decay wherein a neutron changes into a proton and an electron
- Gravity
  - Weakest force of them all
  - However, it's famous because it works over great distances.
  - Attracts all objects to all other objects in the universe.