UNIT 2: Atoms and Elements

CHEMISTRY = <u>CHEM IS TRY!!</u>

Like math, chemistry takes practice! TRY it, do the work, let me know if you need extra help, and let's help you succeed!

<u>MATTER</u>

WHAT IS MATTER?

- ***Matter*** is anything that…
    1. has mass
    2. takes up space
- Can matter change? YES!!

PROPERTIES OF MATTER

- A ***property*** is a characteristic that we can use to describe something.
- There are ***physical properties*** and ***chemical properties***.

PHYSICAL PROPERTIES

- A physical property <u>does not</u> involve a substance becoming a new substance.
- There are many types of physical properties that you can observe with your senses!
- ***Color*** - red, green, colorless…?
- ***Texture*** - smooth, fine, coarse…?
- ***Odor*** – odorless, spicy, burnt…?
- ***Lustre*** – shiny, dull…?
- ***<u>Taste</u>*** <u>- sour, salty, sweet, …?</u>
- ***States of matter*** at <u>room temp</u>. (solid, liquid, or gas! ***See descriptions in chart below!***)

	Solid	Liquid	Gas
Example			
Shape	Definite: has a fixed (unchanging) shape.	Indefinite: always takes the shape of its container.	Indefinite: always takes the shape of its container.
Volume	Definite: has a fixed volume.	Definite: has a fixed volume.	Indefinite: always fills the entire container.

- ***Hardness*** - the measure of the resistance of a solid to being scratched or dented.
    - A hard material will dent or scratch a soft one.
    - Ex. Diamond will cut glass.

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- ***Malleability*** - the ability for a solid to be bent or hammered into different shapes.
    - Ex. Aluminum foil
    - Opposite of brittle. Brittle objects shatter easily.
- ***Ductility*** – when a solid can be pulled into long, thin wires.
    - Ex. Copper is used for electrical wiring
- ***Melting / Boiling Points*** – the temperatures at which substances change state.
    - Ex. Water changes to steam at 100°C, this is known as its boiling point.
- ***Crystal Form*** – some solids form into definite structures of cubes or blocks with a regular pattern.
    - Ex. grains of salt
- ***Solubility*** – the ability of a substance to dissolve in a solvent such as water.
    - Ex. Kool-Aid
    - Ex. Salt vs. Pepper
- ***Viscosity*** – refers to how easily a liquid flows. The thicker the liquid, the more viscous it is (slower).
    - Ex. Molasses flows more slowly than water
- ***Density*** – is the amount of matter per unit volume of that matter (kg/m3).
    - Ex. Lead is "heavier" than a feather

CHEMICAL PROPERTIES

- A ***chemical property*** describes the behavior of a substance as it becomes a new substance.
- ***Example:*** Dynamite explodes when exposed to a flame because the dynamite combines with oxygen in the air. This reaction produces new substances.
- ***Combustibility*** – a property that describes the ability of a substance to react with oxygen to produce carbon dioxide, water and energy.
    - Ex. Gasoline is flammable or combustible.
- ***Reaction with Acid*** – the ability of a substance to react with acid.
    - Ex. When magnesium metal is added to acid, it produces bubbles of gas and the metal disappears.

USING THE PROPERTIES OF MATTER

- Matter can be grouped as ***metals*** and ***nonmetals***.
- Metals have special properties that make them suitable for many different uses.
- ***Alloys*** - Metals that are mixed together to form a mixture that has different properties.
    - Ex. Different alloys are found in airplane parts, the bottoms of cooking pots, and braces for teeth. The metals chosen have physical and chemical properties that are useful for the job.

PHYSICAL AND CHEMICAL CHANGES

- Physical Change
    - the substance involved remains the same substance, even though it may change state or form.
    - Most physical changes are easy to reverse.
    - Examples:
        - Changes of state
        - Dissolving

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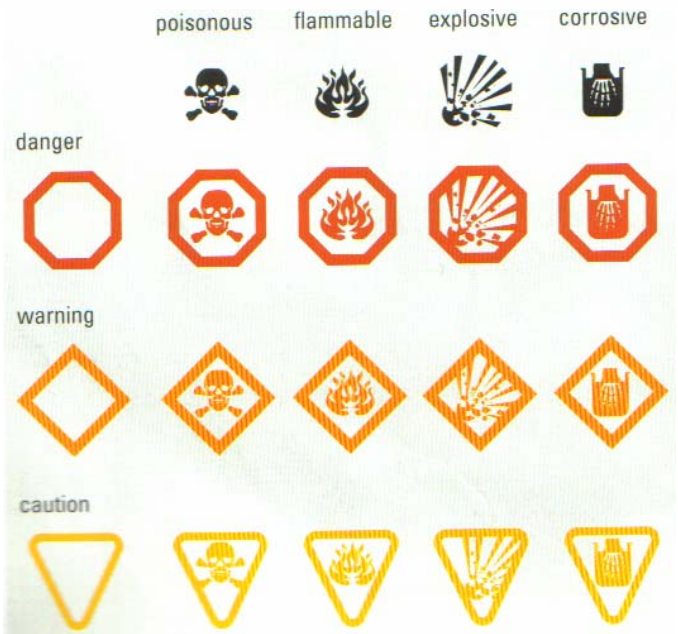
- Chemical Change
  - The original substance is changed into one or more different substances that <u>have different properties</u>!
  - Always involve the production of new substances
  - Most chemical changes are difficult to reverse.
  - Examples:
    - Burning
    - Cooking
    - Rusting
  - Clues that *suggest* a chemical change has occurred:
    - 1. A new color appears
    - 2. Heat or light is given off
    - 3. Bubbles of gas are formed
    - 4. A precipitate forms in a liquid
    - 5. The change is difficulty to reverse
  - The clues above can also accompany a physical change so you must conside several clues to determine what type of change has occurred!

CHEMICALS AND SAFETY

Chemicals and SAFETY!

1. Hazardous Household Product Symbols

- Indicate WHY and TO WHAT DEGREE a product is dangerous!

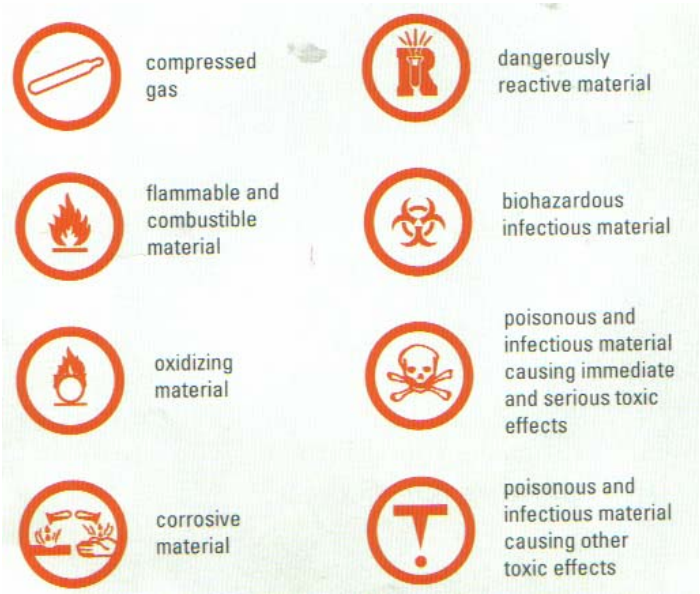


Chemicals and SAFETY!

2. WHMIS

Workplace Hazardous Materials Information System

- Developed to standardize the labeling of dangerous materials used at workplaces (an schools!)



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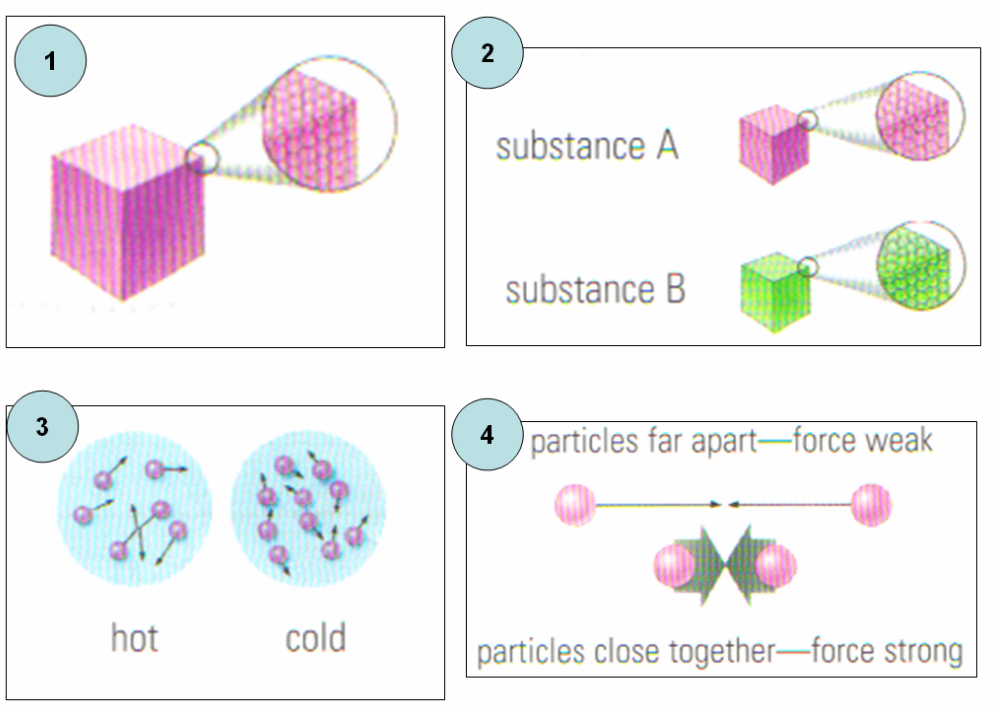
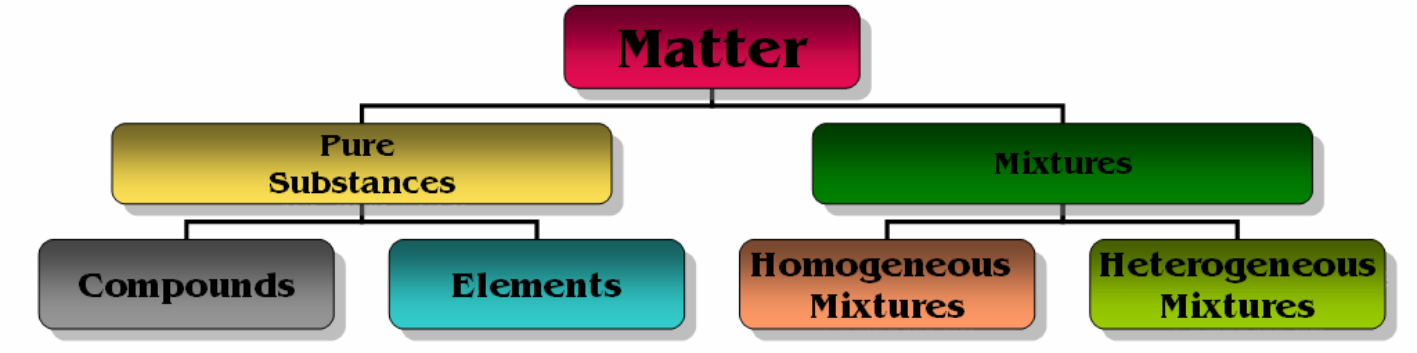
THE PARTICLE THEORY OF MATTER

1. All matter is made up of tiny particles.
2. All particles of one substance are the same. Different substances are made of different particles.
3. The particles are always moving. The more energy the particles have, the faster they move!
4. There are attractive forces between the particles. These forces are stronger when the particles are closer together!



CLASSIFICATION OF MATTER



- ***Matter*** – anything that has mass and occupies space.
  – can be divided into *mixtures* and *pure substances.*

  - ***Mixtures*** – Mixtures contain at least two substances.

    - ***Homogeneous Mixtures*** – AKA solutions
      – looks uniform (ie. can't see the separate components).
      – One substance basically dissolves in another.
      – Can be made up of solids, liquids, or gases.

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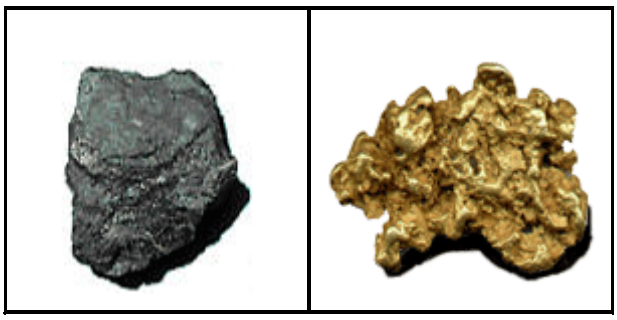
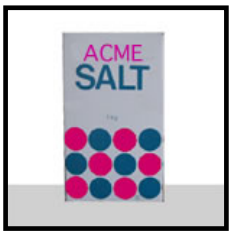
- ***Heterogeneous Mixtures*** – AKA mechanical mixture
  – contain two or more visible substances that can be separated by mechanical (physical) means (ex. picking it out with your fingers or filtering, evaporation of water).

- ***Pure Substance*** – Contain only one kind of particle
  – Have properties that are always the same.

  - ***Elements*** – can not be broken down into simpler substances. (Ex. carbon & gold)
    – There are over 100 known elements in the world! (See periodic table)
    – Elements are like the letters of the alphabet – can't be broken down!





- ***Compounds*** – contain two or more different elements bonded in a fixed proportion. (EX. Water is H_2O, carbon dioxide is CO_2).
  – the elements can only be separated if the bonds between them are broken. Bonds between elements can only be broken by a chemical reaction!
  – Compounds are like words…they can be broken down into letters!

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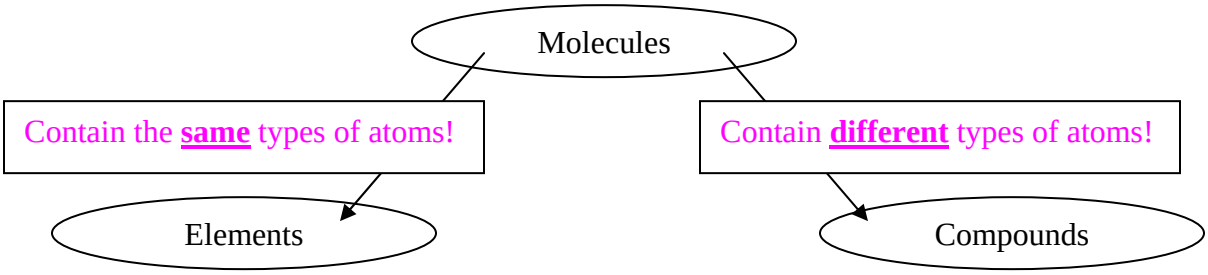
ATOMS

- Everything is made up of atoms! (People used to just call them "particles" before they knew what they were!)
- Each element is made up of only one kind of atom. (There are over 100 elements, therefore there are over 100 kinds of atoms!)
- Atoms join together in combinations to form ***molecules***!

MOLECULES

- Formed when two or more atoms join together.
- Can contain two atoms or may thousands!
- Can contain the ***same types of atoms*** (ex. oxygen is O_2) or ***different types of atoms*** (ex. butane is C_4H_{10}).



- Elements can combine in different ratios to produce different substances.
  - Ex. Sugar $C_6H_{12}O_6$, acetic acid CH_3COOH.
  - Ex. Water H_2O, hydrogen peroxide H_2O_2.

CHEMICAL SYMBOLS

- Our periodic table is full of them!
- All countries use the same chemical symbols to represent elements and compounds, even if the name is different! Ex. ***Fe*** represents iron (Canada), fer (France), and fier (Romania)
- ***Chemical Symbol*** – an abbreviation of the name of an element.
  - Ex. ***Hg*** is mercury. Comes from latin word *hydrargyrum* for "liquid silver"
  - Ex. ***Na*** is sodium. The symbol comes from the latin word *natrium*, the name *sodium* comes from a headache remedy called *sodanum*.
- A single letter symbol is always capitalized.
  - B- boron, N- nitrogen, C- carbon, etc.
- A two-letter symbol includes a capitalized first letter and the second is lowercase.
  - Cl- chlorine, Br- bromine, Al- aluminum

CHEMICAL FORMULAS

- ***Chemical formula*** - the combination of chemical symbols that represent a particular compound.
  - Indicates two things:
    1. which elements are present
    2. the number of atoms of each element (proportion)
- The number of elements is represented by a number subscript (a little number in the lower right corner of the symbol). Ex. CO_2, H_2O, $BaCl_2$

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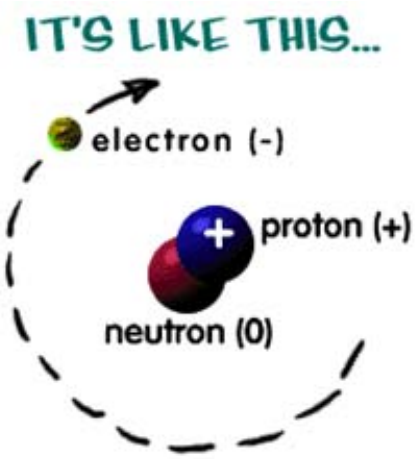
- If there is more than one atom of that element in the compound, the symbol of that element is followed by a small number written below the line (a subscript!).
- If only one atom of an element is present, no number is included! (The symbol itself already represents that there is only one atom there).

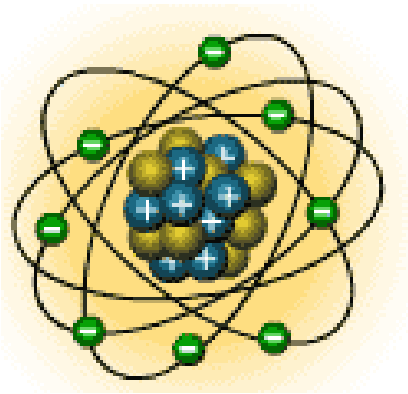
INSIDE THE ATOM

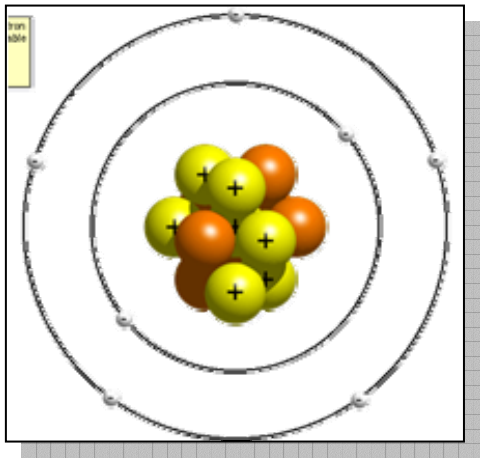
- Most of the atom is empty space. There is a dense central core called the ***nucleus***, and a set amount of space around it.
- The atom is filled with three different types of ***subatomic particles***.
  - ***Subatomic particles*** – the particles of which an atomic composed.
  - Theses particles are described in terms of their relative mass to each other, their electrical charge, and their location.

Subatomic Particle	*Relative Mass*	*Electrical Charge*	*Location*
Proton	1	positive (+)	nucleus
Neutron	1	neutral	nucleus
Electron	~0	negative (–)	orbit around the nucleus

  - The electrons travel very quickly in set paths around the nucleus called ***energy levels*** (AKA ***orbitals or shells***). These paths are located at set distances away from the nucleus.
  - The nucleus is tiny as compared to the whole size of the atom; most of the size of the atom is determined by the distance of the energy levels.
  - Because the nucleus is composed of just protons and neutrons, the nucleus is positively charged overall!
  - Since protons and neutrons both have mass, the atom itself has mass! Because the protons and neutrons are located in that dense region called the nucleus, the mass of the atom is concentrated in the nucleus.







- The number of protons is CRUCIAL! The number of protons in the atom will determine what type of atom it is.
  - Ex. Any atom with 1 proton is a hydrogen atom.
    Any atom with 7 protons is a nitrogen atom.
- An atom itself has no electric charge….it is neutral overall!

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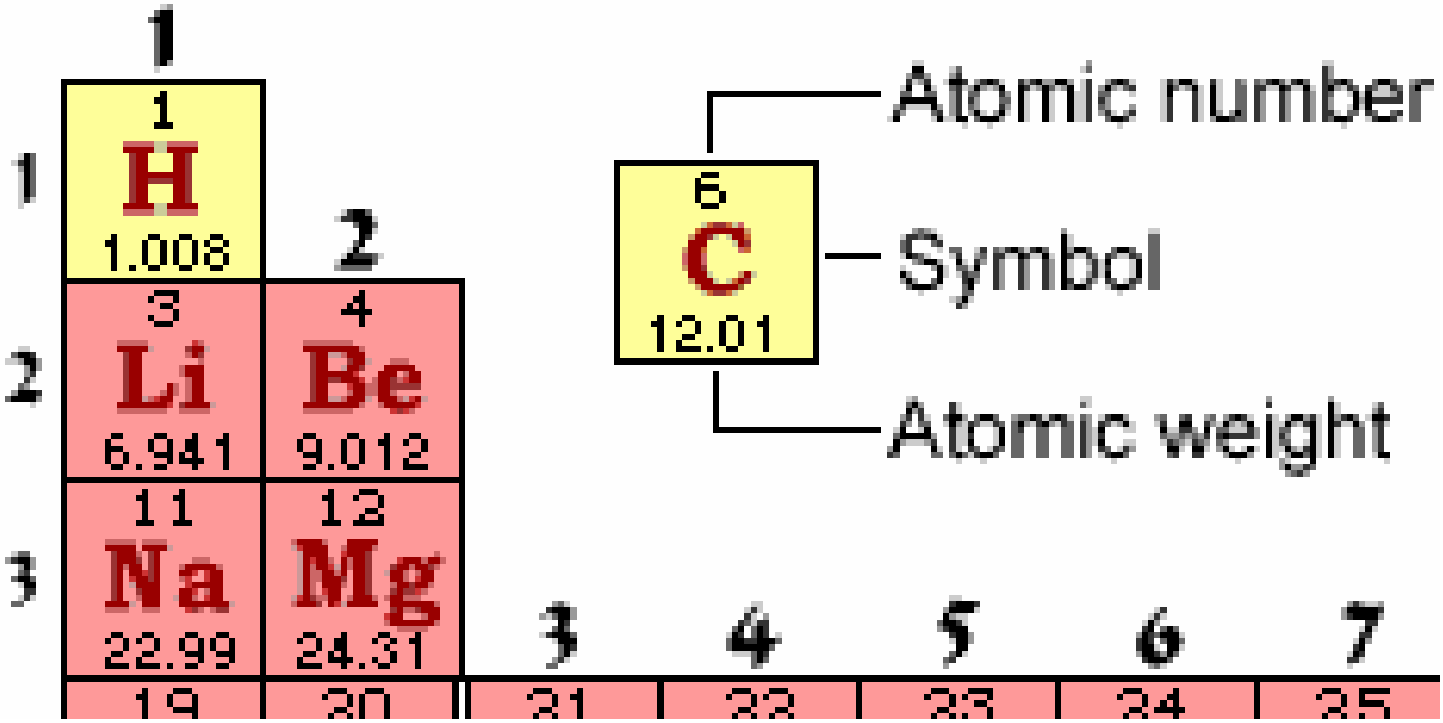
- In order for it to be neutral, all of the positive charge has to be "cancelled out" by an equal amount of negative charge.
- THEREFORE, an atom has an equal number of electrons and protons.
  - Ex. Hydrogen has 1 proton so it also has 1 electron
    Nitrogen has 7 protons so it also has 7 electrons

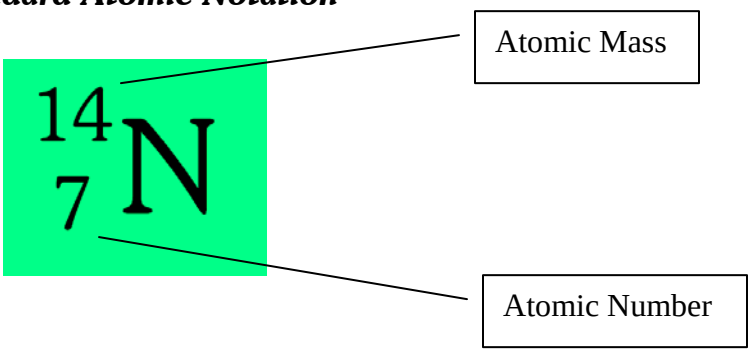
COUNTING SUBATOMIC PARTICLES

- How many electrons, protons, and neutrons are in each different type of atom?



- ***Atomic Number*** – the number of ***protons*** in an atom.
  - If you know the atomic number of an atom, you know both the number of protons AND the number of electrons that the atoms has!
- ***Atomic Mass*** – Represents the sum of the protons and neutrons in an atom.
  - # protons + # neutrons = Atomic Mass
  - THEREFORE, if you know the atomic number (the number of protons) and the atomic mass (the sum of protons and neutrons), you can easily calculate the number of neutrons.
    - atomic mass – atomic number = # neutrons.

- ***Standard Atomic Notation***



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MODELS OF THE ATOM

- ***Bohr Diagrams***
  - List the number of protons and number of neutrons as seen in the diagram below. This represents the nucleus of the atom.
  - Knowing that there are just as many electrons as there are protons, start drawing and filling in the electrons as thick black dots as seen in the diagram.
    - Draw the ***first energy level*** – it can only hold ***2 electrons!***
    - If needed, you can continue drawing energy levels so until all of the electrons have a "home". The ***second, third, and fourth energy levels*** can all hold up to ***8 electrons!***
  - IMPORTANT SIDE NOTES:
    - The farther away an electron is from the nucleus, the more energy it has!
    - Electrons only exist in their orbits, not between them!
    - The outer-most shell is called the ***valence*** shell.