Chapter 1

Atoms, Elements, Compounds and Mixtures

1 – 1 Models of the Atoms

History of the Atom

- Scientists have not always had the tools that we have now.
- A long time ago, scientists did not have any tools other than their five senses and their ability to reason.

Predict the Outcome

- What would be the end result if you took an aluminum bar and cut it in half, then cut one of the halves in half, then cut it in half, etc… ?

- Early scientists theorized that eventually you would not be able to cut it in half any more.
  - Only one particle would be left.
  - They named these particles ‘Atoms’
    - Atoms means ‘cannot be divided’
- Scientists could not study this because they lacked the tools to see things this small.

Chemistry

- This curiosity about matter led to the field of science called ‘Chemistry’.
- Chemistry means ‘the study of matter’.

Model of the Atom

- In the 1700's, scientists were putting substances together to see what was formed.
  - Scientists were also taking substances apart to see what they were made of.
- Eventually scientists realized that there are things that cannot be taken apart.

Elements

- Element – a substance that cannot be broken down into simpler substances.
  - Examples : Gold, Silver, Copper, Oxygen

John Dalton

- Developed a theory on matter in the early 1800's.

1. Matter is made up of atoms.
2. Atoms cannot be divided into smaller pieces.
3. All of the atoms of an element are exactly alike.
4. Different elements are made of different kinds of atoms.

Dalton's Atomic Model

- He envisioned an atom as a hard sphere that was the same throughout.

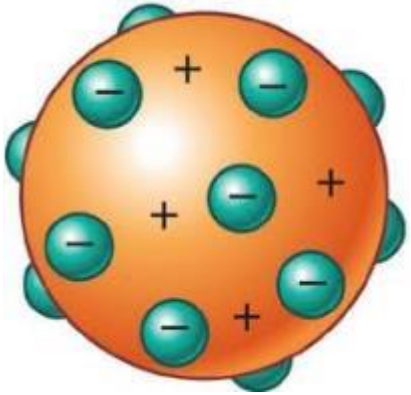
J.J. Thomson

- In 1897, Thomson used a cathode ray tube in his experiments.
  - A tube that is a vacuum and has electricity passed through it.
- Thomson bent the ray of light inside the tube using a magnet.
- Because of this, Thomson knew that the particles in the ray of light had a negative charge.

- Thomson called these negatively charged particles ‘electrons’.
- Electron – a negatively charged particle that exists in an electron cloud formation around an atom’s nucleus.
- Thomson tested many gases inside his cathode ray tube and found that the electrons existed inside all of the gases.
  - He theorized that electrons are present in all atoms.
  - This means that there are things smaller than atoms.

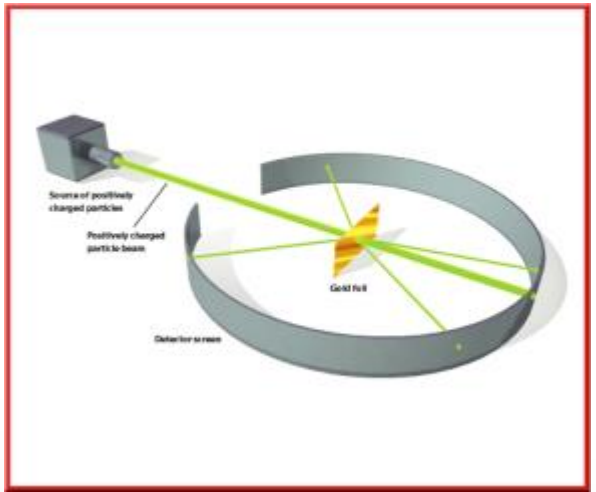
Thomson's Atomic Model

- A positively charged sphere that has negatively charged electrons spread evenly throughout.



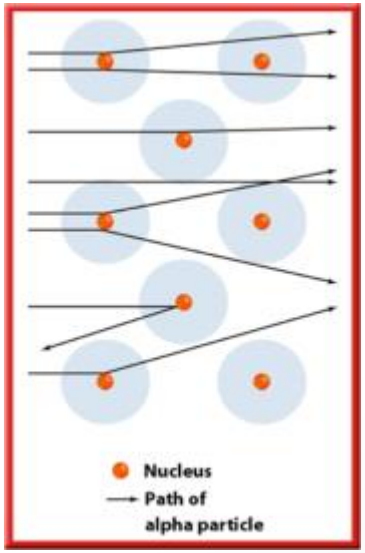
Ernest Rutherford

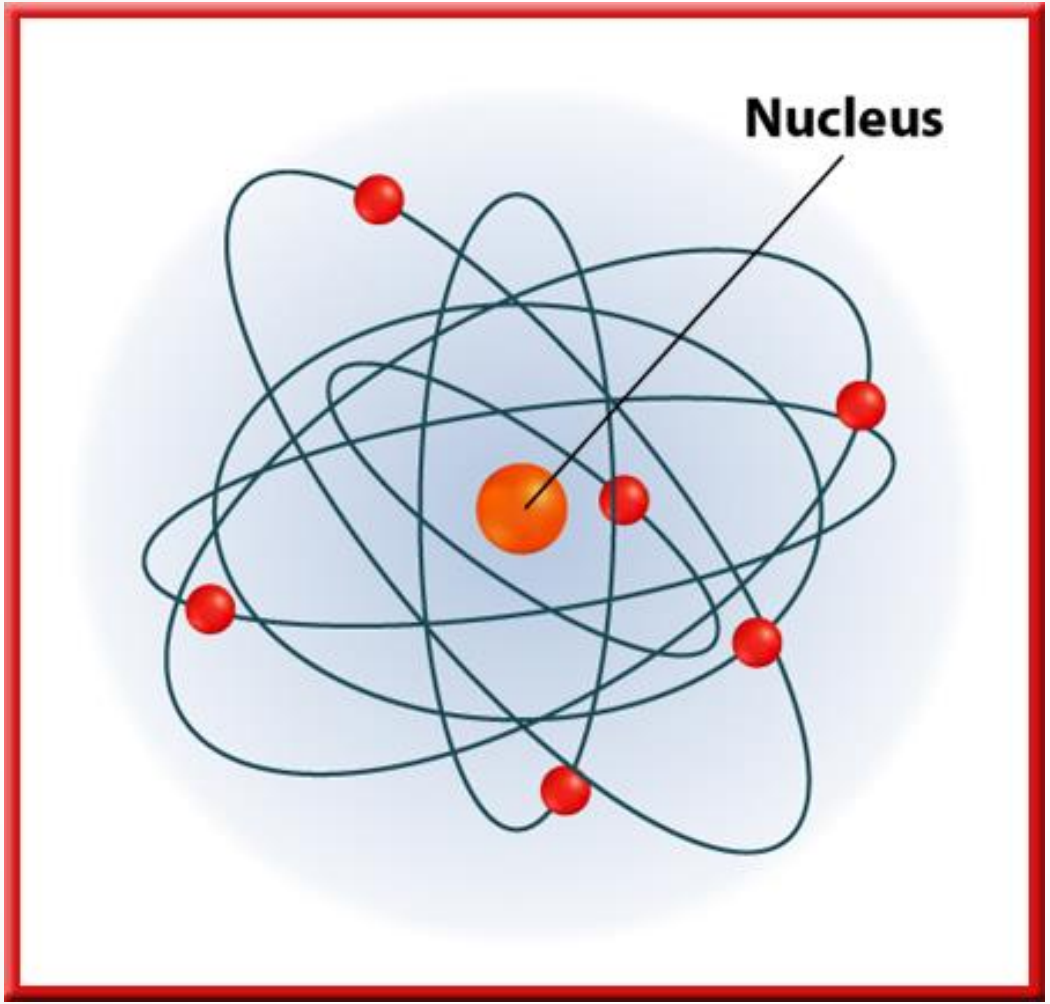
- Rutherford shot alpha particles through some gold leaf (very thin gold… 1 – 3 atoms thick)
- Rutherford expected the alpha particles to blast right through the gold and not be deflected.



Rutherford's Atomic Model

- He theorized that almost all of the mass is crammed into a very small area in the center of the atom.
  - This area is called the 'nucleus'.
  - Nucleus – center of an atom.




Nucleus

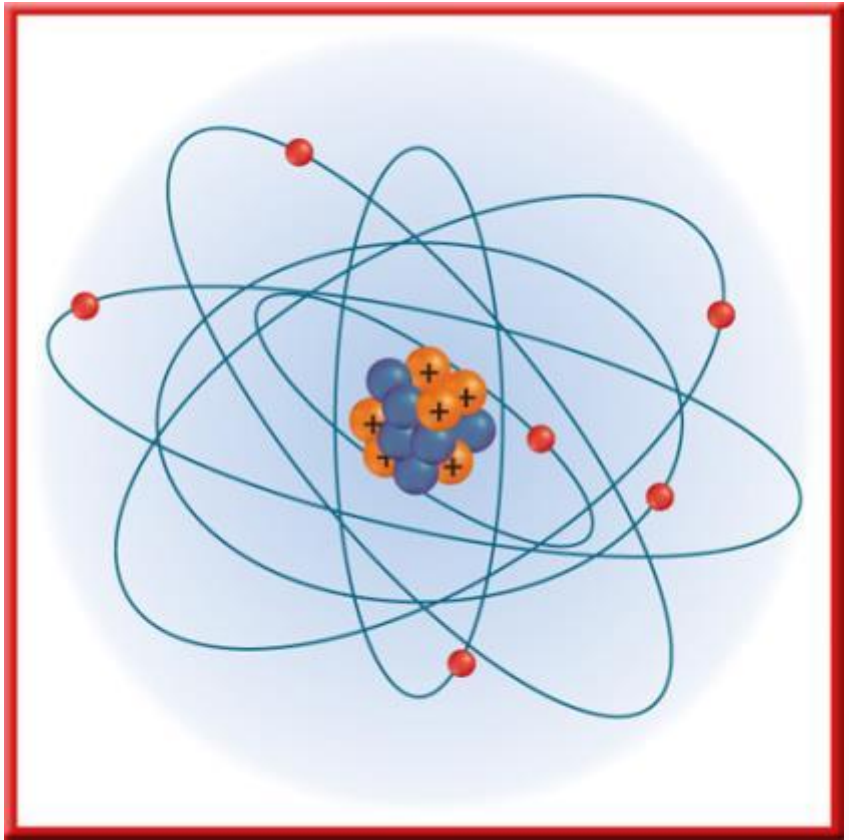
Proton

- Rutherford theorized that all of the positive charge was located in the nucleus.
  - Proved true in 1920.
- Proton – positively charged particle in the nucleus of an atom.

Neutron

- Scientists soon learned how to mass an atom.
  - The scientists learned that there was something else in an atom that had mass.
  - That something else had no charge.
- Neutron – electrically neutral particle that has the same mass as a proton and is found in an atom's nucleus.
  - It took another 20 years for scientists to prove this theory.

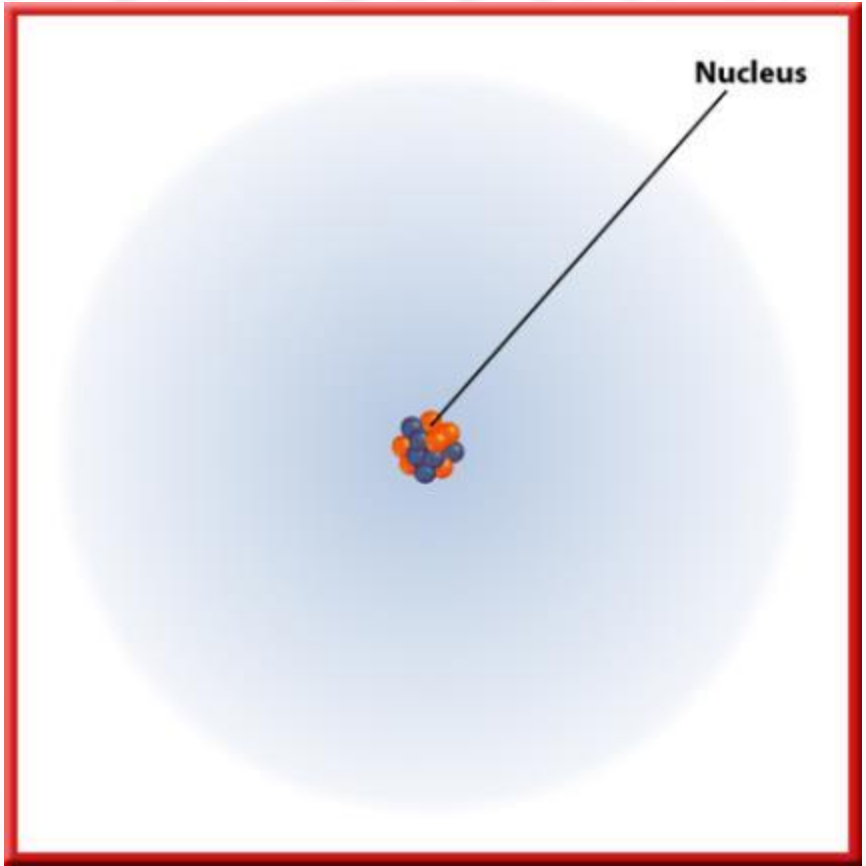
Nuclear Atom



Electron Cloud Model

- Scientists thought that electrons followed paths and orbited the nucleus.
- When scientists developed a method for locating an electron, they found something else.
- Electrons do not follow a path, they are unpredictable.
- Electron Cloud – region surrounding the nucleus of an atom, where electrons are most likely to be found.

Electron Cloud Model



Subatomic Particles

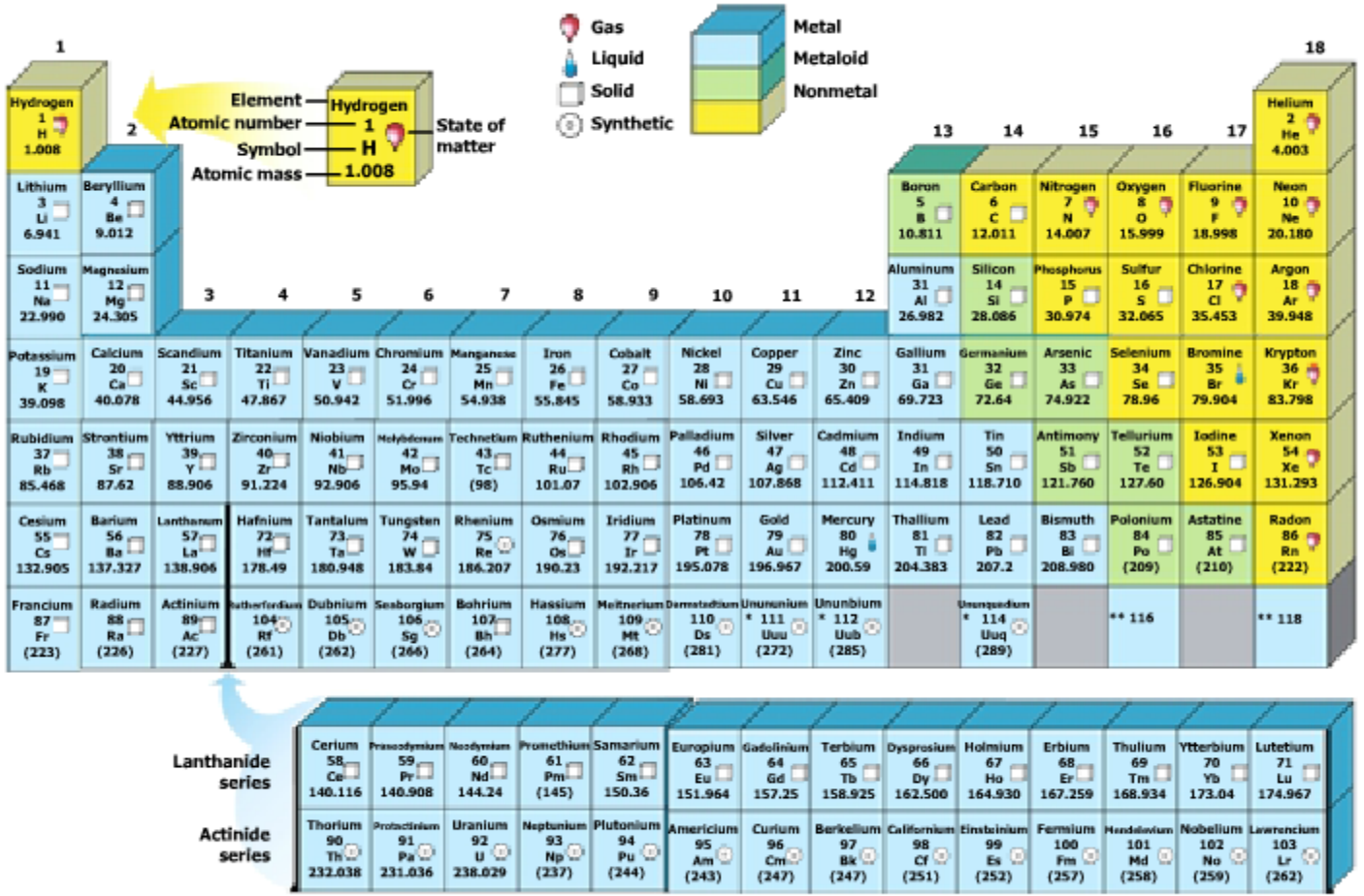
- Subatomic Particles are the particles that make up an atom.
  - Nucleus – located in the center of the atom
    - Proton – Positively charged particle that has a mass of 1 amu.
    - Neutron – No charge and has a mass of 1 amu.
  - Electron Cloud – region outside the nucleus where electrons are located
    - Electron – Negatively charged particle that has almost no mass.

1 – 2 The Simplest Matter

Periodic Table of Elements

- There are at least 115 elements.
  - 90 of these elements occur naturally on Earth
  - The other elements are known as 'Synthetic' Elements
  - Synthetic – Manmade.
- They are organized on a chart called the 'Periodic Table of Elements'.

PERIODIC TABLE OF THE ELEMENTS



Groups

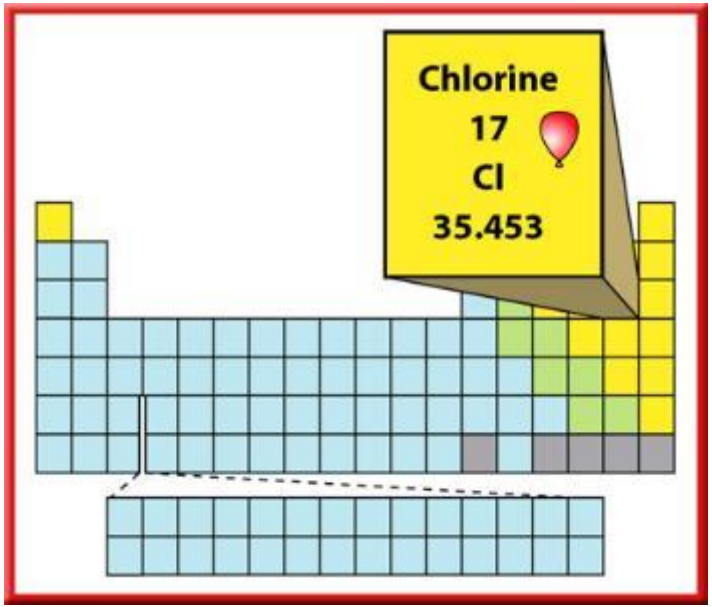
- Columns on the Periodic Table of Elements.
- The elements in a group have similar chemical properties.

Periods

- Rows on the Periodic Table of Elements.
- The elements in a period have the same number of energy levels.

Atomic Number

- Atomic Number - the number of Protons in an atom.
- The whole number on top in an element key



Mass Number

- Mass Number – The number of protons and neutrons located in the nucleus.

Isotopes

- In nature, not every atom of an element has the same number of neutrons.
- Isotope – Atoms of the same element that have different numbers of neutrons.
- The mass number is used to specify which isotope is being used.
  - Example - H-1 and H-2

Average Atomic Mass

- (Average) Atomic Mass – Average mass of an atom of an element; its unit of measure is the atomic mass unit (u), which is 1/12 the mass of a carbon-12 atom.
  - Due to isotopes, some atoms of the same element have different weights (because they have different numbers of neutrons).
  - Scientists take a sample from nature and then average the masses.

Classification of Elements

- 3 general categories
  1. Metals
  2. Nonmetals
  3. Metalloids

Metals

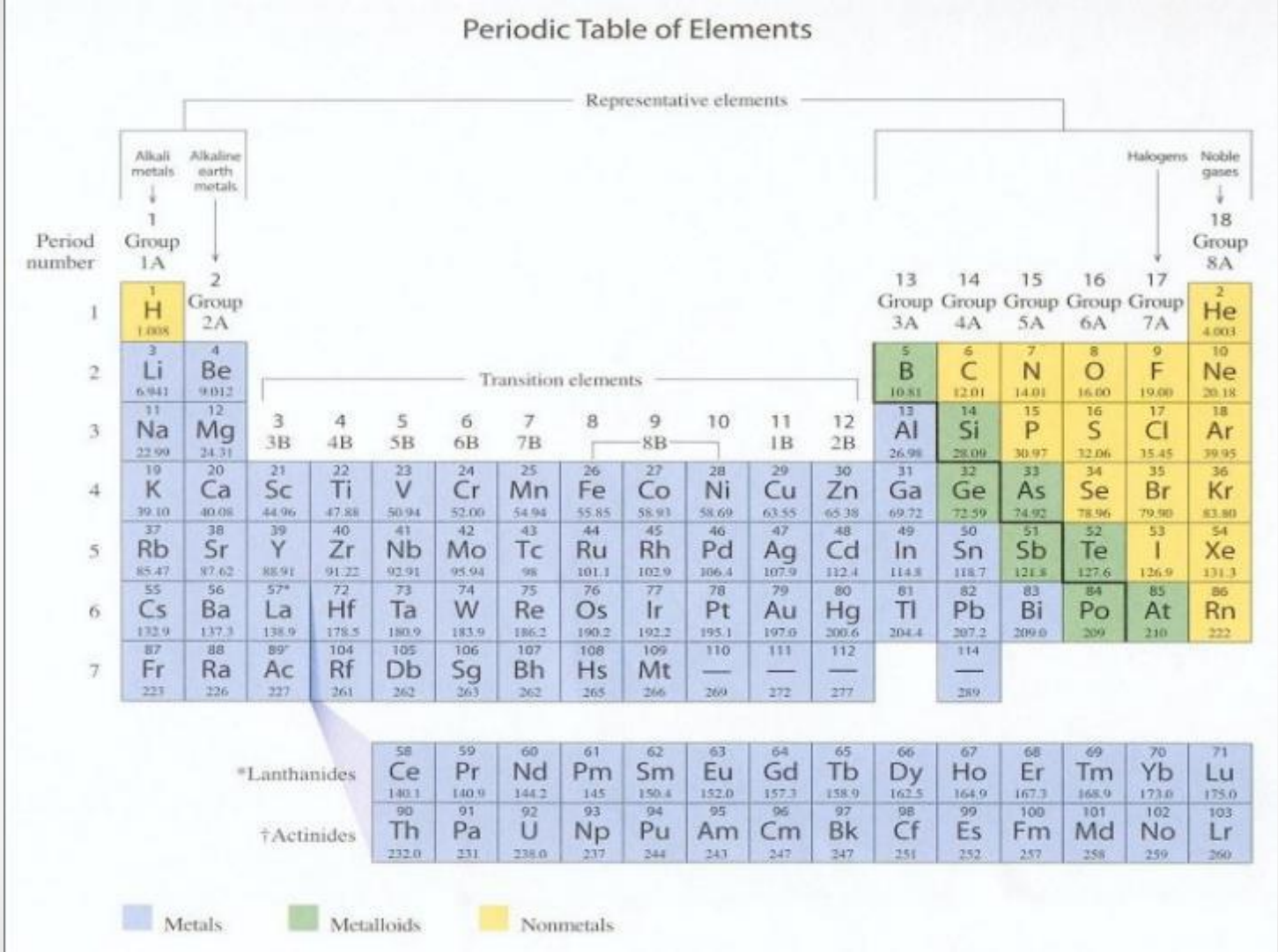
- Element that is malleable, ductile, a good conductor of electricity, and generally has shiny or metallic luster.
  - Malleable – Can be bent or pounded into shapes.
  - Ductile – Can be stretched into wires.
  - Luster - Shiny

Nonmetals

- Nonmetals – Element that is usually a gas or a brittle solid at room temperature, is a poor conductor of heat and electricity, and is dull.
  - Brittle – Easily broken when made to change shape.

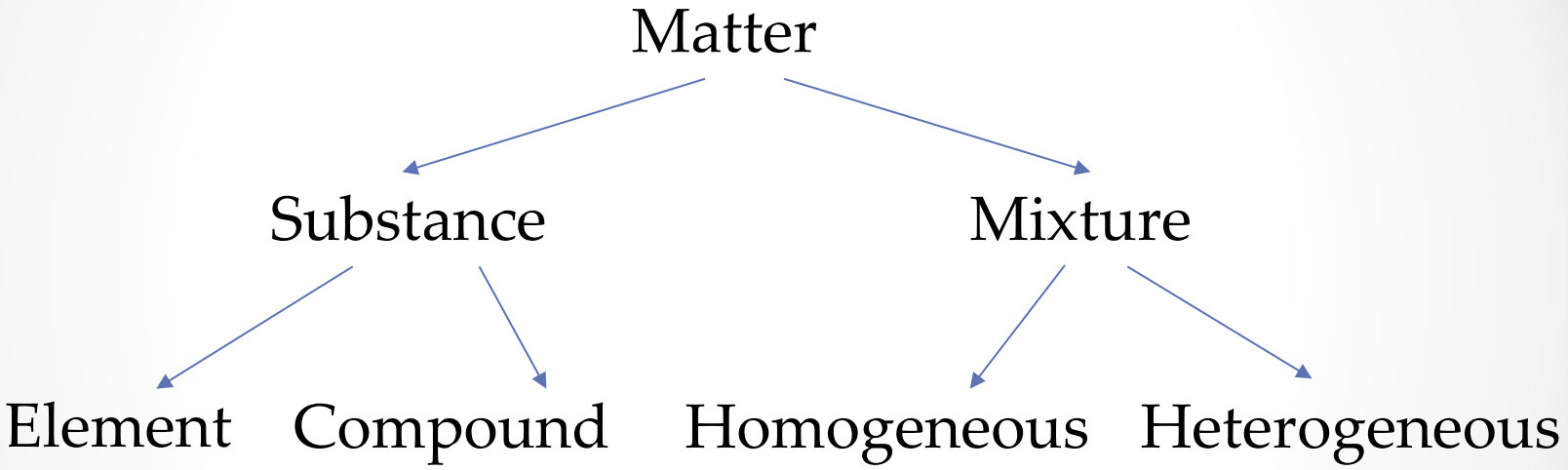
Metalloid

- Metalloid- Element that shares some properties with both metal and nonmetals.


Periodic Table of Elements
Representative elements
Alkali metals
Alkaline earth metals
Halogens
Noble gases
Period number
1 Group 1A
2 Group 2A
13 Group 3A
14 Group 4A
15 Group 5A
16 Group 6A
17 Group 7A
18 Group 8A
Transition elements
3 3B
4 4B
5 5B
6 6B
7 7B
8
9 8B
10
11 1B
12 2B
1 H 1.008
2 He 4.003
3 Li 6.941
4 Be 9.012
5 B 10.81
6 C 12.01
7 N 14.01
8 O 16.00
9 F 19.00
10 Ne 20.18
11 Na 22.99
12 Mg 24.31
13 Al 26.98
14 Si 28.09
15 P 30.97
16 S 32.06
17 Cl 35.45
18 Ar 39.95
19 K 39.10
20 Ca 40.08
21 Sc 44.96
22 Ti 47.88
23 V 50.94
24 Cr 52.00
25 Mn 54.94
26 Fe 55.85
27 Co 58.93
28 Ni 58.69
29 Cu 63.55
30 Zn 65.38
31 Ga 69.72
32 Ge 72.59
33 As 74.92
34 Se 78.96
35 Br 79.90
36 Kr 83.80
37 Rb 85.47
38 Sr 87.62
39 Y 88.91
40 Zr 91.22
41 Nb 92.91
42 Mo 95.94
43 Tc 98
44 Ru 101.1
45 Rh 102.9
46 Pd 106.4
47 Ag 107.9
48 Cd 112.4
49 In 114.8
50 Sn 118.7
51 Sb 121.8
52 Te 127.6
53 I 126.9
54 Xe 131.3
55 Cs 132.9
56 Ba 137.3
57* La 138.9
72 Hf 178.5
73 Ta 180.9
74 W 183.9
75 Re 186.2
76 Os 190.2
77 Ir 192.2
78 Pt 195.1
79 Au 197.0
80 Hg 200.6
81 Tl 204.4
82 Pb 207.2
83 Bi 209.0
84 Po 209
85 At 210
86 Rn 222
87 Fr 223
88 Ra 226
89† Ac 227
104 Rf 261
105 Db 262
106 Sg 263
107 Bh 262
108 Hs 265
109 Mt 266
110 —— 269
111 —— 272
112 —— 277
114 —— 289
*Lanthanides
58 Ce 140.1
59 Pr 140.9
60 Nd 144.2
61 Pm 145
62 Sm 150.4
63 Eu 152.0
64 Gd 157.3
65 Tb 158.9
66 Dy 162.5
67 Ho 164.9
68 Er 167.3
69 Tm 168.9
70 Yb 173.0
71 Lu 175.0
†Actinides
90 Th 232.0
91 Pa 231
92 U 238.0
93 Np 237
94 Pu 244
95 Am 243
96 Cm 247
97 Bk 247
98 Cf 251
99 Es 252
100 Fm 257
101 Md 258
102 No 259
103 Lr 260
Metals
Metalloids
Nonmetals

1 – 3
Compounds and Mixtures

Classification of Matter



Substances

- Substance – Matter that has the same composition and properties throughout.
- Two types of substances :
  1. Element – substance that cannot be broken down into simpler substances.
  2. Compound – substance produced when elements combine and whose properties are different from each of the elements in it.

Chemical Formulas

- Tells you which elements make up a compound as well as how many atoms of each element are present.

H_2O H_2O_2 CO_2

2 – Hydrogen

1 - Oxygen

Mixtures

- Mixture – A combination of compounds and elements that has not formed a new substance and whose proportions can be changed without changing that mixture's identity.
- Two types of mixtures :
  1. Homogeneous Mixture – the same throughout
  2. Heterogeneous Mixture – different parts of the mixture can be seen