

Physical Science

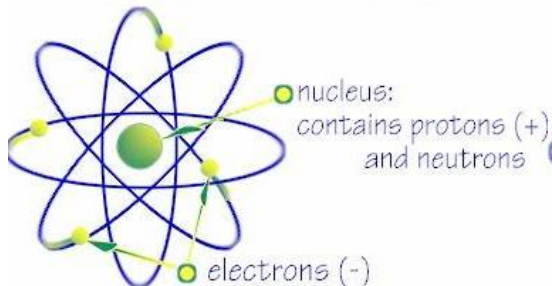
Chapter 16

The Periodic Table

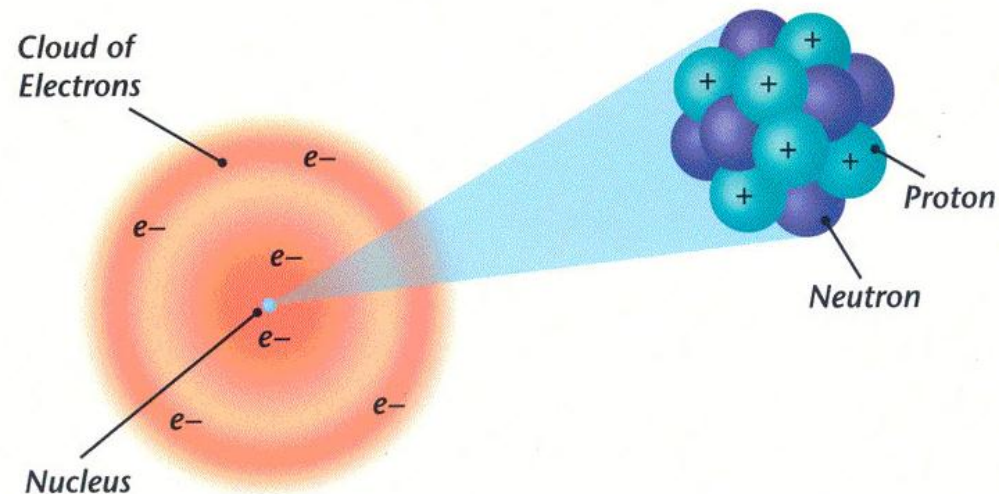
Parts of an Atom

- An atom consists of a nucleus surrounded by one or more electrons
- Atoms are electrically neutral w/ the same number of protons as electrons.
- Majority of the atom is empty space. If nucleus were the size of a pencil eraser, the closest electron would be 100 yards away!
- Subatomic Particles
 - Protons
 - Neutrons
 - Electrons
- Nucleus: Tightly packed Protons & Neutrons
- Electrons Orbiting nucleus @ 1 % speed of light!!

Structure of An Atom

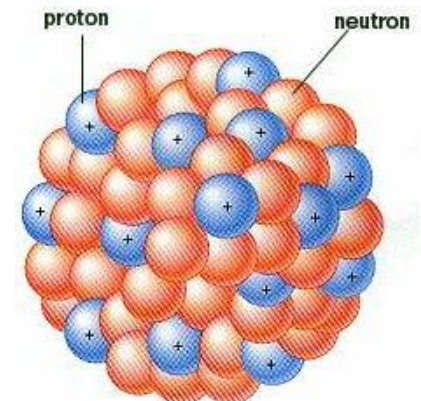
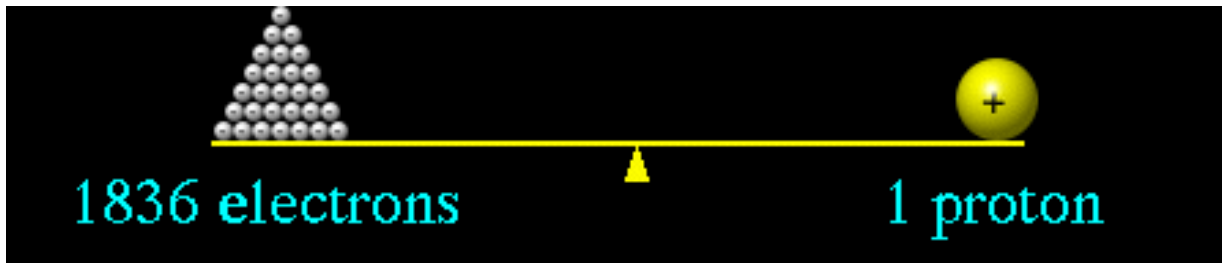


8 Model of a Carbon Atom



Atomic Mass

- How much does an atom “weigh”?
- What is the mass of an atom?
- SI Unit for mass is the Gram.... Way toooo big to accurately “mass” an atom
- Came up w/ new unit, an AMU (atomic mass unit)
- **1 AMU = mass of 1 Proton**
- mass of subatomic particles
 - **Proton = 1 AMU**
 - **Neutron = 1 AMU**
 - **Electron = .0005 AMU**
- **Atomic Mass** = the total # of both **Protons & Neutrons** in the atom
 - (we don’t worry about the mass of the electrons since they have almost no mass)



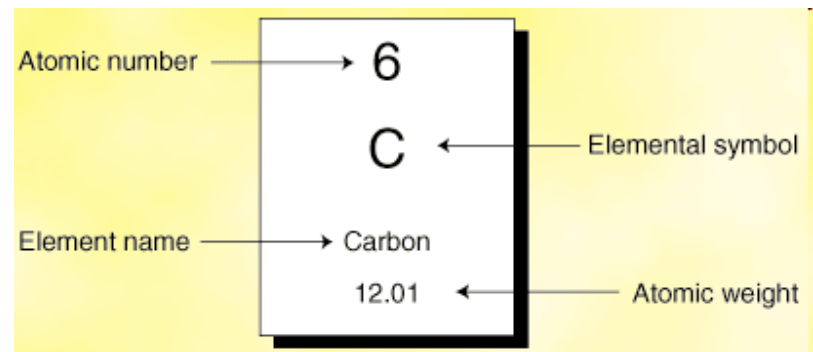
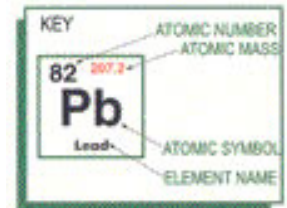
Atomic Number

- By definition:
 - The Atomic Number = the number of Protons present in the nucleus of an atom
- Each Element in the Periodic Table has a different number of Protons, therefore each element has a different, unique, atomic number.

“Small” number is always the atomic #, therefore the number of protons present

“Large” number is always the Atomic Mass which tells us the total # of both Protons & Neutrons present

When reading the Periodic table notice each element has a unique 1 or 2 letter symbol and “big” & “small” number listed



Electrical Atomic Charge

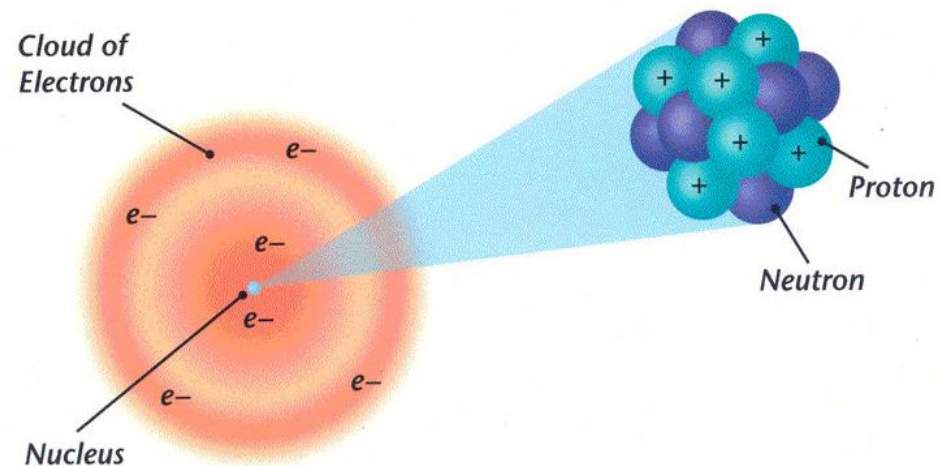
- Electrical charge – all atoms have a neutral charge
 - (a zero net electrical charge)
- **P**rotons have a **p**ositive (+) electrical charge
- **N**eutrons have a **n**eutral (0) electrical charge
- Electrons have a **n**egative (-) electrical charge
- Since the net electrical charge is 0 (neutral), if you have 10 Protons (10 “+” charges) then there must be 10 “-” charges (10 electrons) present to balance out the atom.
- Therefore, as long as you know the **Atomic #**, you know the **# of Protons** and also the **# of Electrons**!!

Atomic number	→ 6	
	C	← Elemental symbol
Element name	→ Carbon	
	12.01	← Atomic weight

For example:

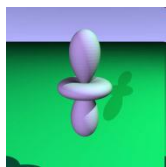
Carbon has an atomic # of 6, it therefore has 6 Protons which has an electrical charge of +6, to make the atom neutral we need 6 negative charges found in the 6 electrons orbiting the nucleus.

8 Model of a Carbon Atom

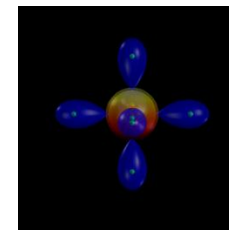


Valence Electrons

- Electrons are found in specific orbits/clouds spinning around the nucleus
- Orbits are named:
1s,2s,2p,3s,3p,3d,4s,4p,4d,4f,5s,5p,5d,5f,6s,6p,6d,6f,7s
- How many in electrons each sub orbit?



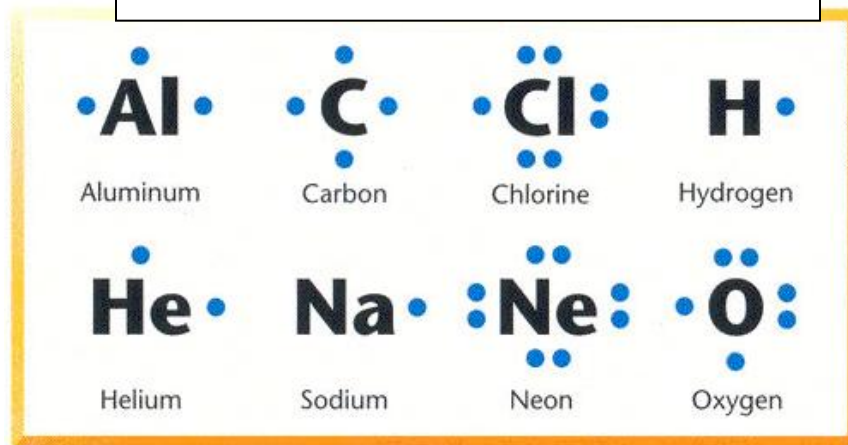
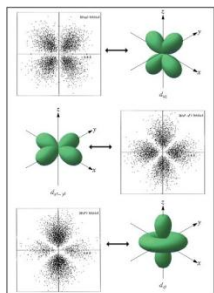
- S sub orbits hold 2 electrons
- P sub orbits hold 6 electrons
- D sub orbits hold 10 electrons
- F sub orbits hold 14 electrons



- **Valence electrons are the electrons located in the outermost orbit**

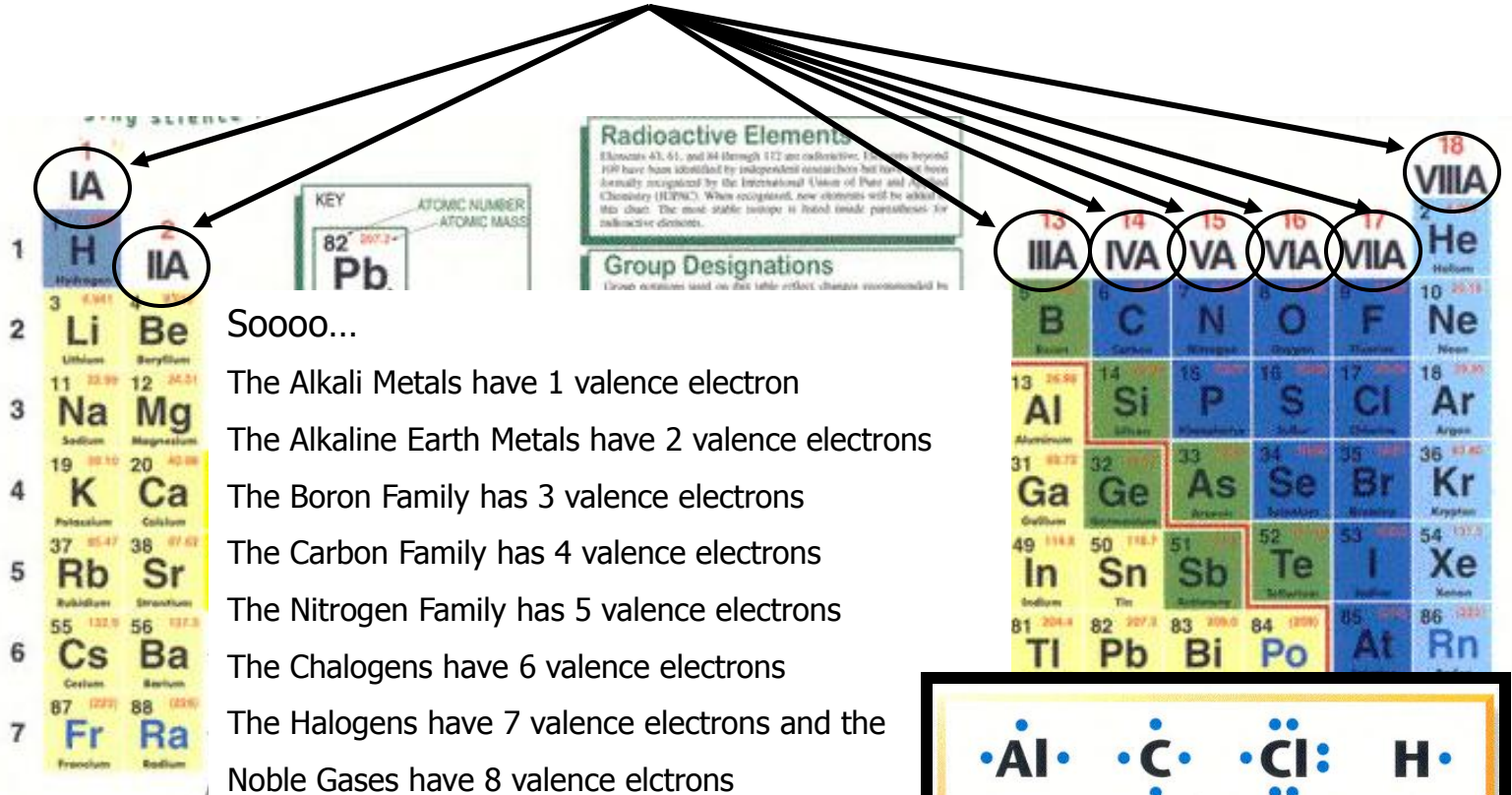
Lewis Dot Diagrams show the # of Valence Electrons

Elements become stable when:
their outer orbit
contains 8 electrons
or their outer orbit
becomes empty



Valence Electrons

- Our Periodic Table also is arranged to easily determine the number of valence electrons an atom has:
- By looking at the "A" group #'s, the Roman numeral identifies the # of valence electrons for the entire group!



Soooo...

The Alkali Metals have 1 valence electron

The Alkaline Earth Metals have 2 valence electrons

The Boron Family has 3 valence electrons

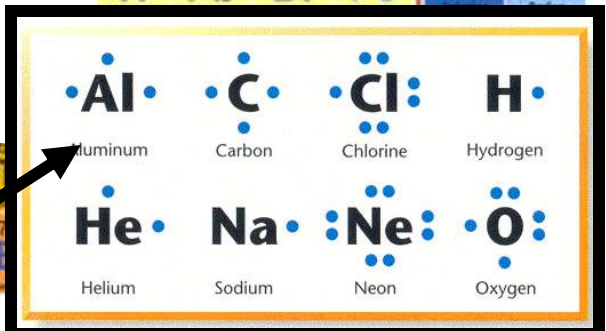
The Carbon Family has 4 valence electrons

The Nitrogen Family has 5 valence electrons

The Chalogens have 6 valence electrons

The Halogens have 7 valence electrons and the Noble Gases have 8 valence elctrons

Lewis Dot Diagrams show the # of Valence Electrons



Element Key
Metals

How many Neutrons are there?

- Remember:
 - The **Atomic # = the # of Protons**
 - The **Atomic mass = The # of both Protons & Neutrons.**
 - Therefore, if you subtract the Atomic # (the number of Protons) from the Atomic mass (the number of both Protons & Neutrons) what is left over must be the number of Neutrons!!

Atomic number	→ 6	
	C	← Elemental symbol
Element name	→ Carbon	
	12.01	← Atomic weight

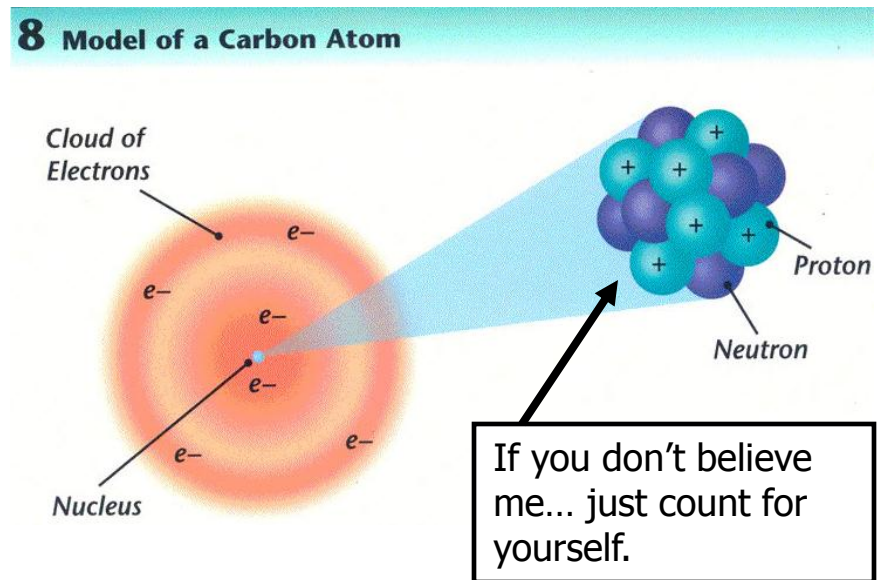
For Example w/ Carbon:

Atomic Mass - Atomic # = # Neutrons

Atomic Mass = 12, Atomic # 6

$$\underline{12 - 6 = 6}$$

Therefore there are 6 neutrons present in the Carbon nucleus



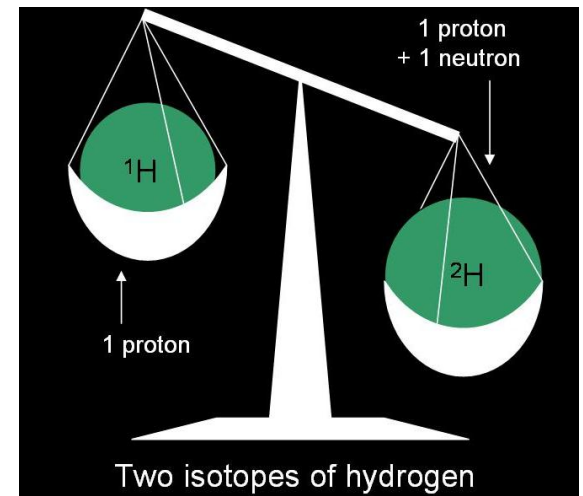
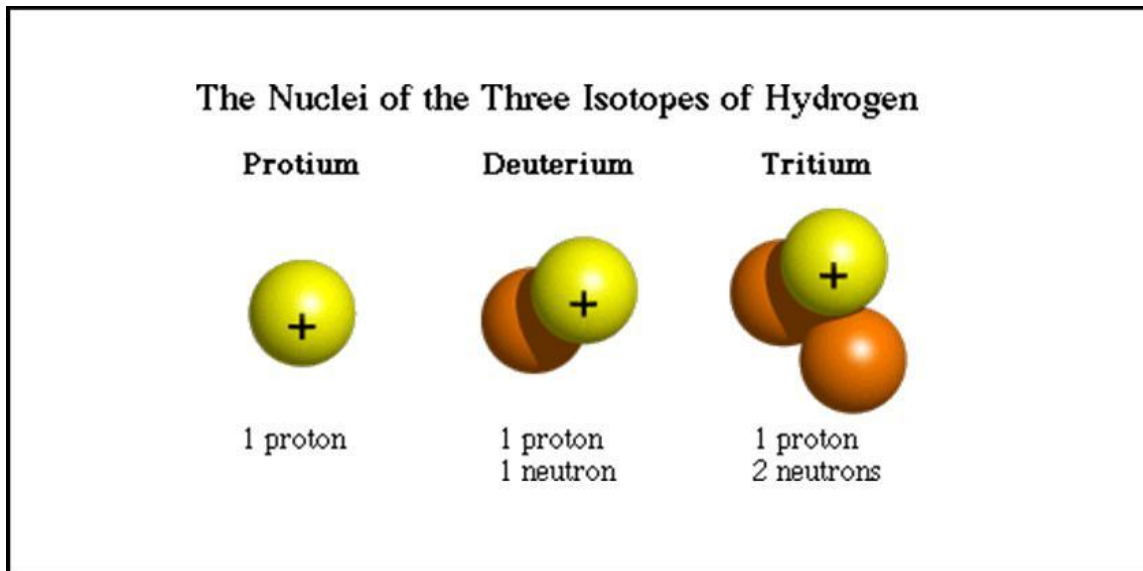
Isotopes

Atoms of the same element can have different numbers of neutrons

The number of Neutrons in an atom will sometimes vary, that's why the atomic mass of the elements is not an even number. For Hydrogen, the mass is 1.008. Most atoms of Hydrogen have 0 neutrons, but some have 1 neutron and a very very few will have 2 neutrons.

When you "weigh" trillions of Hydrogen atoms you find that almost all of them will not have any Neutrons, & several of the atoms will have 1 neutron and maybe 1 or 2 will have 2 Neutrons.

If you were to take an average of all of the Hydrogen atoms in your sample, the atomic mass would reflect the different Isotopes present and be 1.008 AMU's.



Organizing the Elements

- The periodic table is laid out by increasing **atomic number** as you go across and down the table

frey scientific
bringing science to life

Periodic Table and Atomic Data

with illustrated text on nuclear terms

Atomic # increases →

Atomic # increases ↓

Radioactive Elements
Elements 83, 87, and 89 through 112 are radioactive. Elements beyond 112 have been identified by independent researchers but have not been formally accepted by the International Union of Pure and Applied Chemistry (IUPAC). When recognized, new elements will be added to this chart. The most stable isotope is listed inside parentheses for radioactive elements.

Group Designations

Element Key

- Metals
- Transition Metals
- Inner Transition Metals
- Metalloids/Semimetals
- Noble Gases
- Nonmetals
- Unknown Elements

Atomic Fission Process
This simplified diagram illustrates a form of nuclear fission used in the original atom bomb. A neutron (n) is forced to penetrate an atom of uranium 235. The uranium nucleus breaks up into nuclei of krypton and barium with release of 2 neutrons and large quantities of energy. Each released neutron then penetrates another uranium atom to cause an explosive chain reaction.

Thermonuclear Fusion Process
A form of hydrogen reaction used in military weapons is illustrated by this diagram. A source of intense heat, shown here as a uranium fission device, causes the fusion of two hydrogen isotopes - deuterium (D) and tritium (T). Helium nuclei are thus formed along with the release of neutrons and tremendous energy. No chain reaction takes place.

The Source of Solar Energy
Illustrating the solar carbon-nitrogen cycle which results in the fusion of four hydrogen nuclei into one helium nucleus (He⁴) changing it to an isotope of nitrogen (N¹⁴) and releasing large amounts of energy. The unstable N¹⁴ releases a positive electron or positron (e⁺) and changes to stable C¹³. C¹³, penetrated by another hydrogen nucleus, changes to N¹⁴ with much energy release. The cycle continues until finally the fourth hydrogen nucleus causes N¹⁴ to be converted to the original C¹² with the creation of a helium nucleus.

Periods, Groups & Families

Groups & Families are in vertical columns, there are 18 Groups

Periods are Rows

Radioactive Elements
Elements 43, 51, and 64 through 112 are radioactive. Elements beyond 118 have not been identified by independent researchers but have not been formally accepted by the International Union of Pure and Applied Chemistry (IUPAC). When suggested, new elements will be added to this chart. The most stable isotope is listed inside parentheses for radioactive elements.

Group Designations
Group numbers used in this table reflect changes recommended by IUPAC to standardize numbering schemes currently in use. The numbers 1 to 10 shown above will increasingly replace existing group designations IA to VIIA. During a transition period both notations will appear on periodic tables.

Element Key
Metals

8
O
16.0
16
S
32.1
34
Se
79.0
52
Te
127.6
84
Po
(209)

There are **7 numbered Periods** and **18 numbered Groups**
 Families are named in 2 ways, 1st after the top element in the column,
 The Oxygen Family contains O, S, Se, Te & Po.
 2nd way to name them is w/ their "old fashion" names. (see next slide)

“Need-to-Know Families”

“Old Fashion Names” of certain Families

Alkali Metals

Alkaline Earth Metals

Noble Gases

Halogens

Chalogens

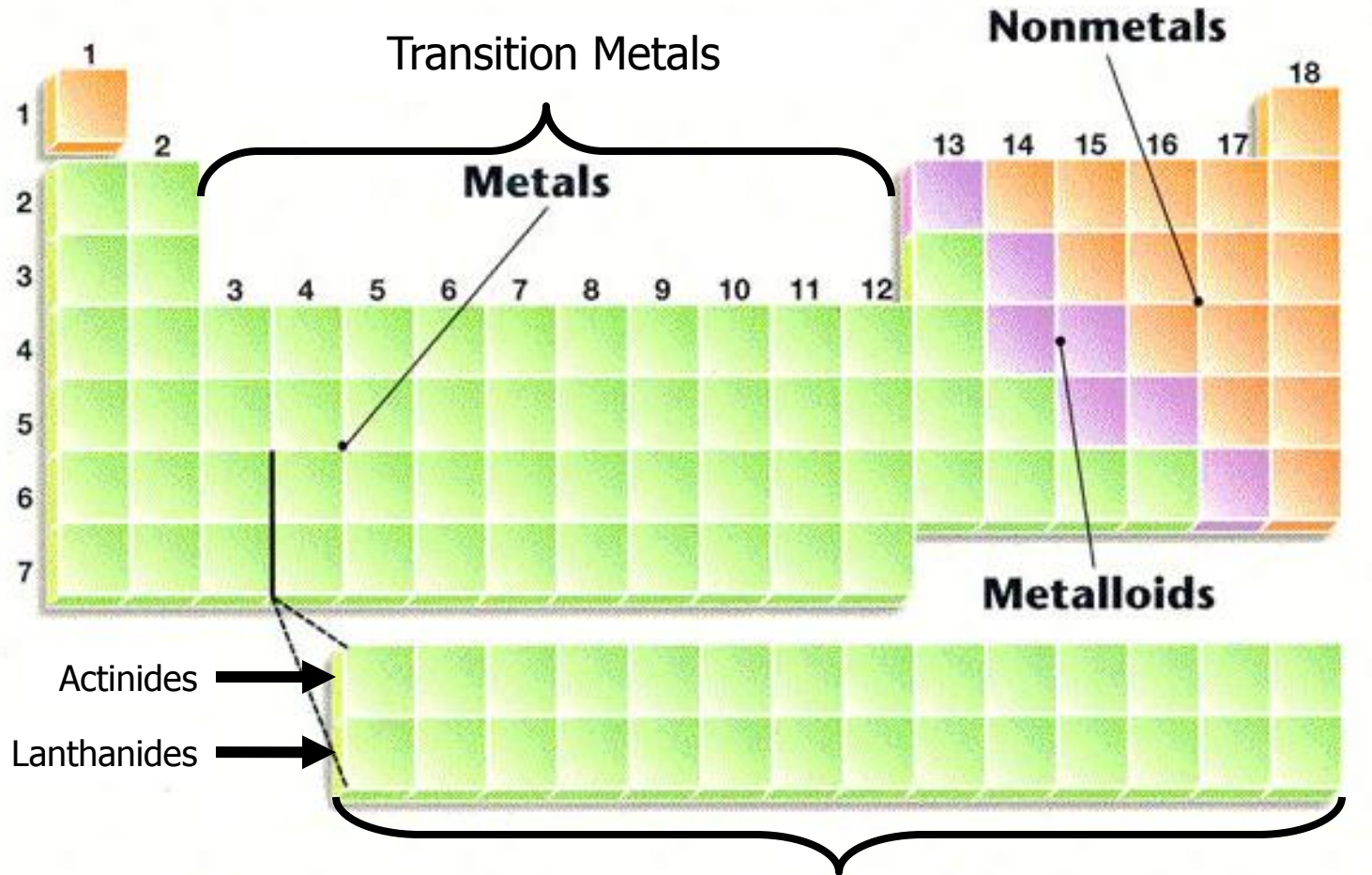
The periodic table is color-coded by groups. The following table shows the elements in each color-coded group:

Alkali Metals (Green)	Alkaline Earth Metals (Blue)	Transition Metals (Teal)	Chalogens (Pink)	Nonmetals (Yellow)	Noble Gases (Orange)
1 H					2 He
3 Li	4 Be			6 C, 7 N, 8 O, 9 F	10 Ne
11 Na	12 Mg			14 Si, 15 P, 16 S, 17 Cl	18 Ar
19 K	20 Ca	21 Sc, 22 Ti, 23 V, 24 Cr, 25 Mn, 26 Fe, 27 Co, 28 Ni, 29 Cu, 30 Zn, 31 Ga	57 La, 89 Ac	32 Ge, 33 As, 34 Se, 35 Br	36 Kr
37 Rb	38 Sr	39 Y, 40 Zr, 41 Nb, 42 Mo, 43 Tc, 44 Ru, 45 Rh, 46 Pd, 47 Ag, 48 Cd, 49 In		50 Sn, 51 Sb, 52 Te, 53 I	54 Xe
55 Cs	56 Ba	72 Hf, 73 Ta, 74 W, 75 Re, 76 Os, 77 Ir, 78 Pt, 79 Au, 80 Hg, 81 Tl		82 Pb, 83 Bi, 84 Po, 85 At	86 Rn
87 Fr	88 Ra				
		58 Ce, 59 Pr, 60 Nd, 61 Pm, 62 Sm, 63 Eu, 64 Gd, 65 Tb, 66 Dy, 67 Ho, 68 Er, 69 Tm, 70 Yb, 71 Lu			
		90 Th, 91 Pa, 92 U, 93 Np, 94 Pu, 95 Am, 96 Cm, 97 Bk, 98 Cf, 99 Es, 100 Fm, 101 Md, 102 No, 103 Lr			

Arrows point from the family names to their respective groups in the periodic table:

- Alkali Metals points to the green group (Li, Na, K, Rb, Cs, Fr).
- Alkaline Earth Metals points to the blue group (Be, Mg, Ca, Sr, Ba, Ra).
- Noble Gases points to the orange group (He, Ne, Ar, Kr, Xe, Rn).
- Halogens points to the yellow group (F, Cl, Br, I, At).
- Chalogens points to the pink group (La, Ac).

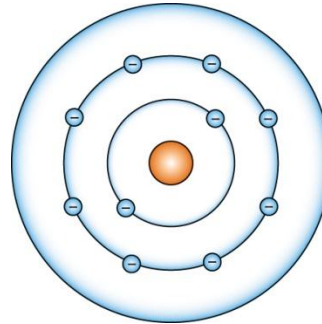
More Need-to-Knows



Rare Earth Elements – AKA Inner Transition Metals

Noble Gases - Group 18

- Non reactive, have a full compliment of valence electrons, 8 and are called the “**Inert Gases**” because they do not react w/ other elements. Examples include **Helium** (very low mass and is used in filling children’s balloons and even airships and the “Goodyear Blimp) and **Neon** used in lighted bulbs to make a red glowing light (a neon light).



2 He 4.0
10 Ne 20.2
18 Ar 40.0
36 Kr 83.8
54 Xe 131.3
86 Rn (222)

Halogens – Group 17

- Very reactive nonmetals w/ 7 valence electrons. Need only one more electron to fill their outer shell. Will steal an electron from a reactive metal to form ionic bonds. Examples include **Chlorine** (the most abundant halogen), **Iodine** and **Bromine** (found in Seawater).

- Physical Properties

Fluorine	yellow gas
Chlorine	green gas
Bromine	volatile brown liquid
Iodine	volatile purple solid



9	F	19.0
17	Cl	35.5
35	Br	80.0
53	I	126.9
85	At	(210)

Chalogens AKA: Oxygen Family – Group 16

- nonmetals w/ 6 valence electrons, need 2 electrons to fill the outer shell. Most common oxidation state is -2. Examples are **Oxygen** (ozone is one of its allotropes), **Sulfur** (responsible for that rotten egg smell when it combines w/ oxygen to form sulfur dioxide) and **Selenium** (one of the few non metals that are also a good conductor of electricity).



8
O
16.0
16
S
32.1
34
Se
79.0
52
Te
127.6
84
Po
(209)

The Alkali Metals – Group 1

- Very reactive metals that have only one valence electron in the outer orbit and will freely give it away to become stable. Very soft metal (you could cut it w/ a plastic knife!). They form ionic bonds w/ Halogens and Chalogens. Examples include **Sodium** and **Potassium**.

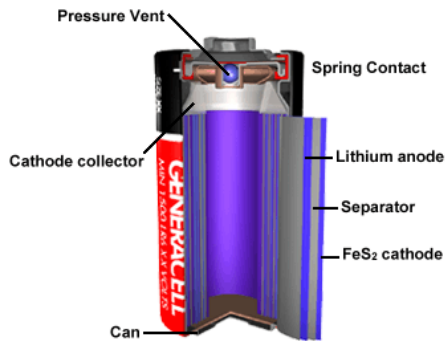
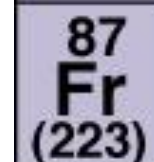
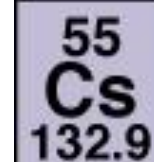
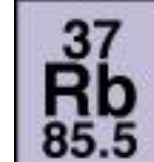
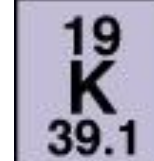
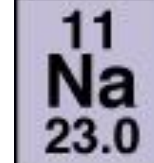
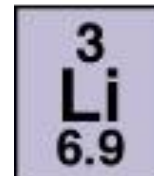
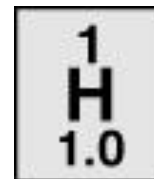


Figure 1



The Alkaline Earth Metals – Group 2

- not as reactive as Alkali Metals, but still very reactive. They have two valence electrons and generally give them up to nonmetals to form ionic bonds. Examples include **Calcium** and **Magnesium**



4 Be 9.0
12 Mg 24.3
20 Ca 40.1
38 Sr 87.6
56 Ba 137.3
88 Ra 226.0

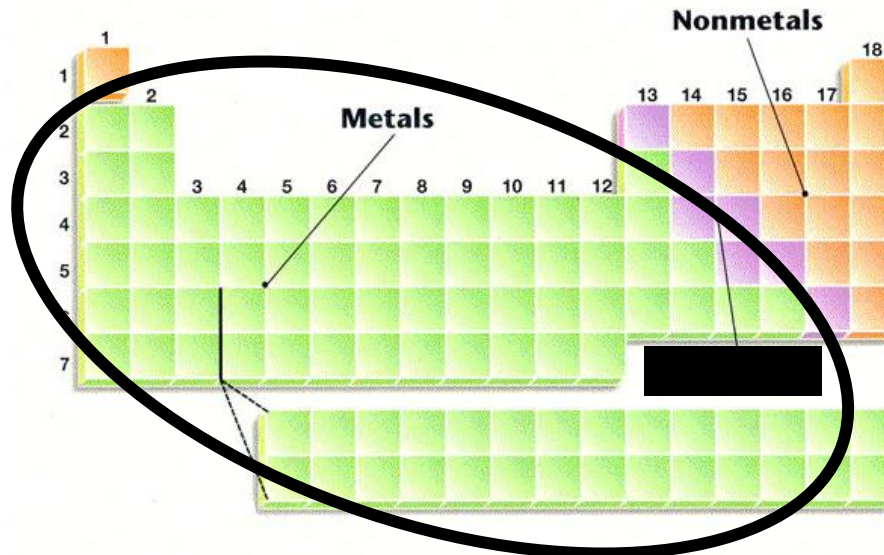
Transition Metals – Groups 3 thru 12

- These all vary dramatically in reactivity, Their oxidation states (# of valence electrons) vary. They are a bridge between the very reactive Alkali and Alkaline Earth Metals and the nonmetals.

21 Sc 45.0	22 Ti 47.9	23 V 51.0	24 Cr 52.0	25 Mn 55.0	26 Fe 55.8	27 Co 59.0	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4
39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (97)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4
71 Lu 175.0	72 Hf 178.5	73 Ta 181.0	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 201.0
103 Lr (260)	104 (261)	105 (262)	106 (263)	107 (264)		109 (266)			

The Metals

- Examples include: **Iron, Tin, Sodium, Calcium, Gallium**
- Most of the elements are metals.
- Metals tend to form positive (+) ions.
- Most form Ionic bonds w/ nonmetals.
- Physical Properties
 - Such as hardness, shiny, **malleability** (pounded into shapes),
 - **ductility** (stretched or pulled into a wire) electrical conductivity and magnetic.
- Chemical Properties
 - Metals show a wide range of chemical properties.



17 Nonmetals

- a. There are **17 nonmetals**, each are located to the right of the zigzag line in the periodic table.
- b. Non metals tend to steal electrons when they form negative (-) ions.
- c. Physical Properties – in general the physical properties of nonmetals are opposite those of metals. Powdery, gaseous, crumbly, non conductive, dull, not ductile or malleable.
- d. Chemical properties – usually form ionic bonds when combined w/ metals (NaCl, FeO₂, and CaCl₂) and usually form covalent bonds when combined w/ other nonmetals (CO₂, O₂, C₆H₁₂O₆)
 - i. Asbestos – substance once used for its fire retardant characteristics but is no longer used because of it's a carcinogen.
- e. Even though **Hydrogen (H)** is located in Group 1, it is still a nonmetal and exhibits oxidation states of +1 and -1.

Nonmetals are the light blue elements

5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 40.0
31 Ga 69.7	32 Ge 72.6	33 As 75.0	34 Se 79.0	35 Br 80.0	36 Kr 83.8
49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)

“Need-to-Know” Elements

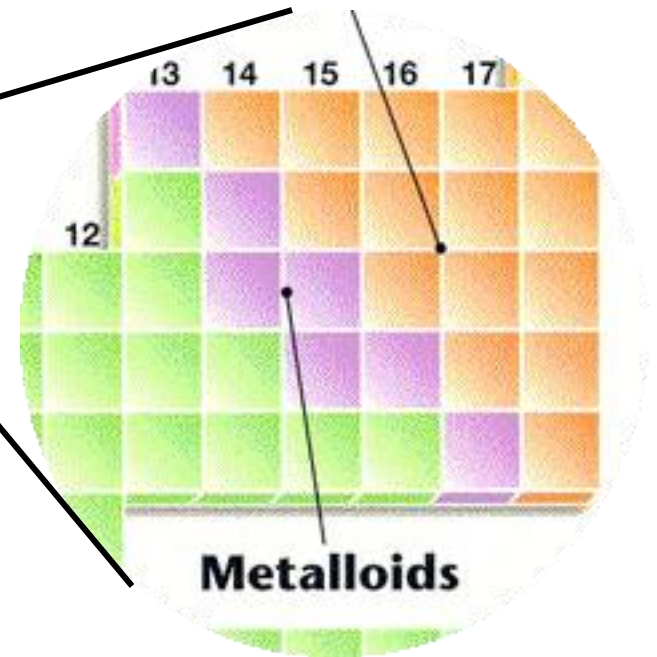
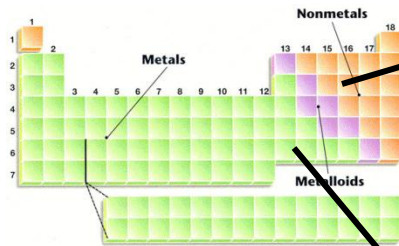
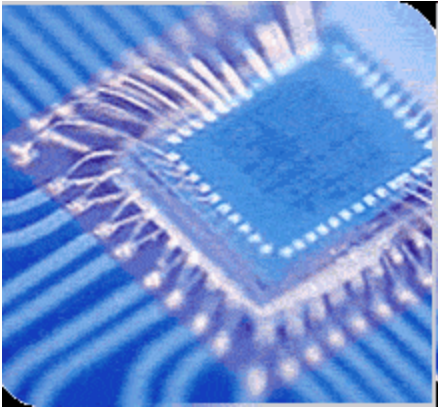
Remember: Atomic Mass – # of Protons = # of Neutrons

Element	Symbol	Atomic Number	Atomic Mass	-	# Protons	=	# Neutrons	# Electrons	Solid Liquid Gas	Metal Metalloid Nonmetal
Hydrogen	H	1	1		1		0	1	G	NM
Oxygen	O	8	16		8		8	8	G	NM
Carbon	C	6	12		6		6	6	S	NM
Nitrogen	N	7	14		7		7	7	G	NM
Calcium	Ca	20	40		20		20	20	S	M
Phosphorus	P	15	31		15		16	15	S	NM
Sulfur	S	16	32		16		16	16	S	NM
Helium	He	2	4		2		2	2	G	NM
Sodium	Na	11	23		11		12	11	S	M
Chlorine	Cl	17	35		17		18	17	G	NM
Aluminum	Al	13	27		13		14	13	S	M
Potassium	K	19	39		19		20	19	S	M

Remember: Atomic # = # of Protons & also # of Electrons

Metalloids

- AKA “semi metals”
- 7 elements on the zigzag border between metals and the non metals.
- Their properties will sometimes make them act like a metal and then sometimes act like a nonmetal.
- Most important characteristic is their varying ability to conduct electricity. Silicon is used to make Semiconductors which are used in making computer chips.



**WE B
FINISHED !!**

All Done !