Atomic Structure and the Periodic Table

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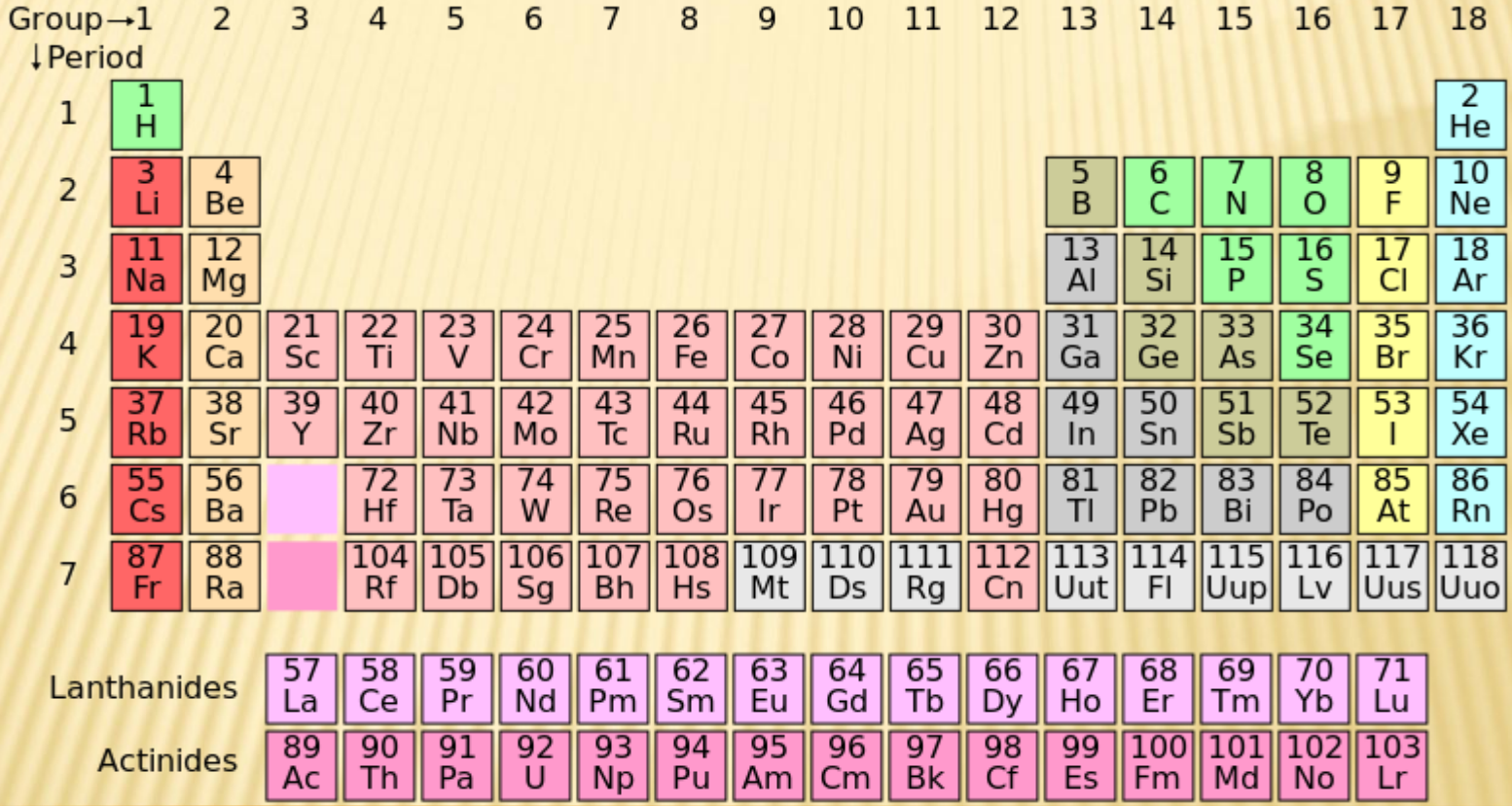
Periodic Table of Elements



Elements

The elements, alone or in combinations, make up our bodies, our world, our sun, and in fact, the entire universe.

Element

Substance that consists of only one type of atom.

Molecule

has two different atoms.

Compound

substance that consists of more than one type of element.

Periodic Table of the Elements

1 IA	2 IIA	3	4	5	6	7	8	9	10	11	12	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
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 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	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 65.41	31 Ga 69.72	32 Ge 72.64	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 (97.9)	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 183.8	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 (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Uuu (272)	112 Uub (277)	113 Uut	114 Uuq	115 Uup	116 Uuh		

*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)	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 (262)

Atomic Structure and the Periodic Table

1. can describe the parts of an atom
2. can read the element information on the periodic table
3. can describe the reactivity of alkali metals
4. can describe how various types of bonding in different categories of materials effects their behavior

Periodic *Table*

The periodic table is a tabular arrangement of the chemical elements, ordered by their atomic number (number of protons in the nucleus), electron configurations, and recurring chemical properties.

The table also shows four rectangular blocks: s-, p- d- and f- block. In general, with in one row (period) the elements are metals on the left hand side, and non-metals on the right hand side.

Periodic *Table*

The rows of the table are called periods; the columns are called groups.

Six groups (columns) have names as well as numbers: for example, group 17 elements are the halogens; and group 18, the noble gases.

The periodic table can be used to derive relation ships between the properties of the elements, and predict the properties of new elements yet to be discovered or synthesized.

The periodic table provides a useful framework for analyzing chemical behavior, and is widely used in chemistry and other sciences.

Periodic *Table*

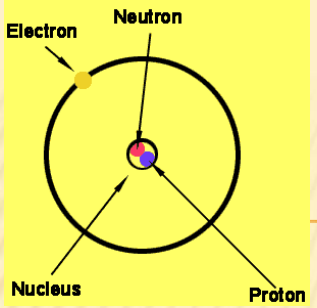
All elements from atomic numbers 1 (hydrogen) to 118 (ununoctium) have been discovered or reportedly synthesis, with elements 113, 115, 117, and 118 having yet to be confirmed. The first 98 elements exist naturally, although some are found only in trace amounts and were synthesisd in laboratories before being found in nature. Elements with atomic numbers from 99 to 118 have only been synthesis in laboratories. It has been shown that einsteinium and fermium once occurred in nature but currently do not. Synthesis of elements having higher atomic numbers is being pursued. Numerous synthetic radionuclides of naturally occurring elements have also been produced in laboratories

Mendeleev

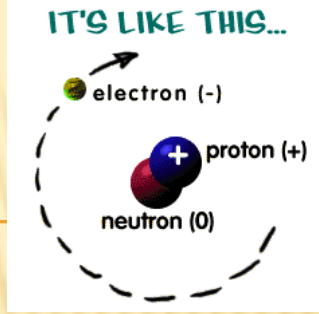
In 1869, Dmitri Ivanovitch Mendeléev created the first accepted version of the periodic table.

He grouped elements according to their atomic mass, and as he did, he found that the families had similar chemical properties.

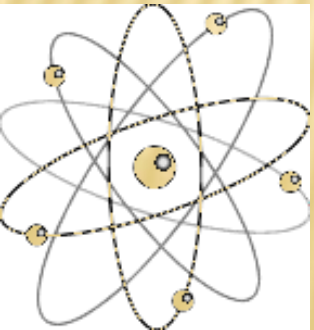
Blank spaces were left open to add the new elements he predicted would occur.

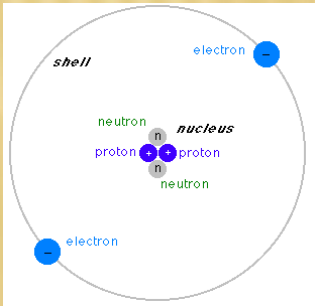


Atoms



- smallest particle of an element that has the properties of the element
- made of 3 basic subatomic particles



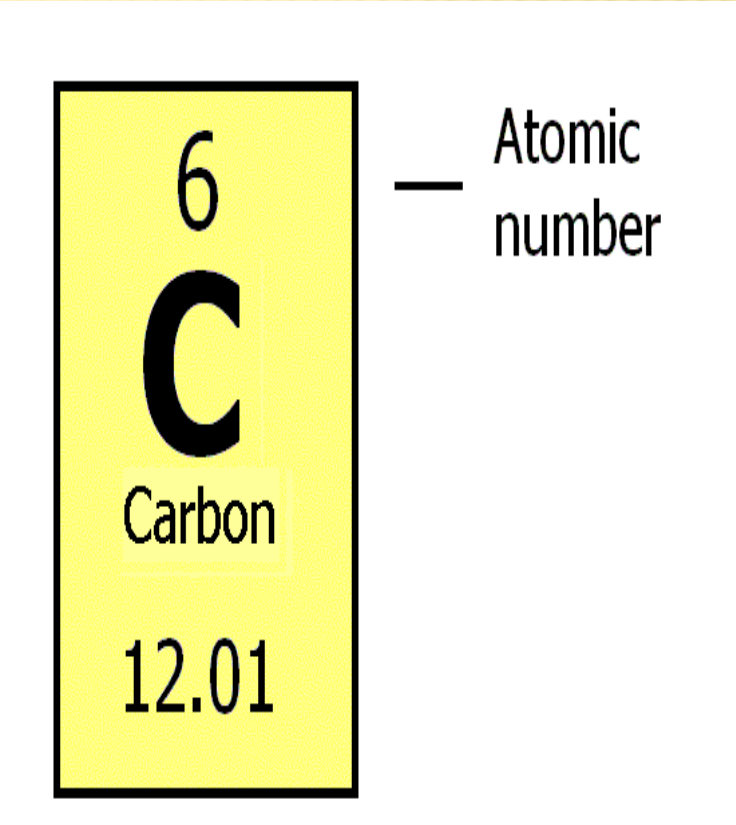


ATOMIC NUMBER?

The number of protons found in the nucleus of an atom

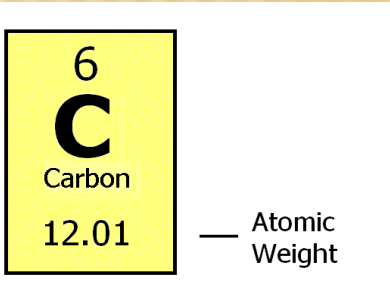
Or

The number of electrons surrounding the nucleus of an atom.



ATOMIC WEIGHT?

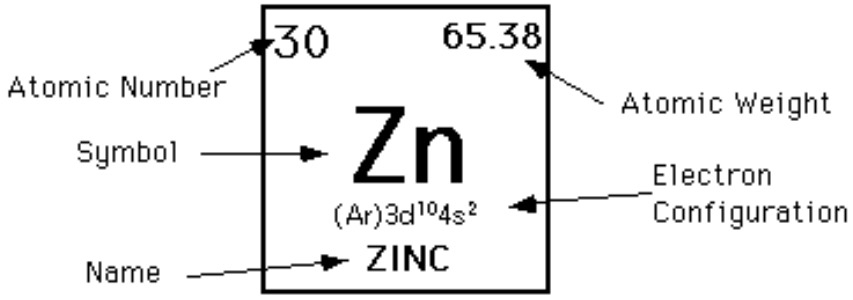
- decimal number on the periodic table – *it is for all the atoms of the element*
- number of protons plus the number of neutrons – *it's an average on the table*
- weighted average of all the isotopes of that element
- the mass of **one** atom is a whole number
- The number of protons and neutrons in the nucleus of an atom**.**



A PROTON?

atomic number

- Positively charged particle.
- Found within an atomic nucleus.
- atomic number
- whole number on periodic table
- number of protons in an atom of an element
- *does NOT vary in an element – the same in all atoms of an element*

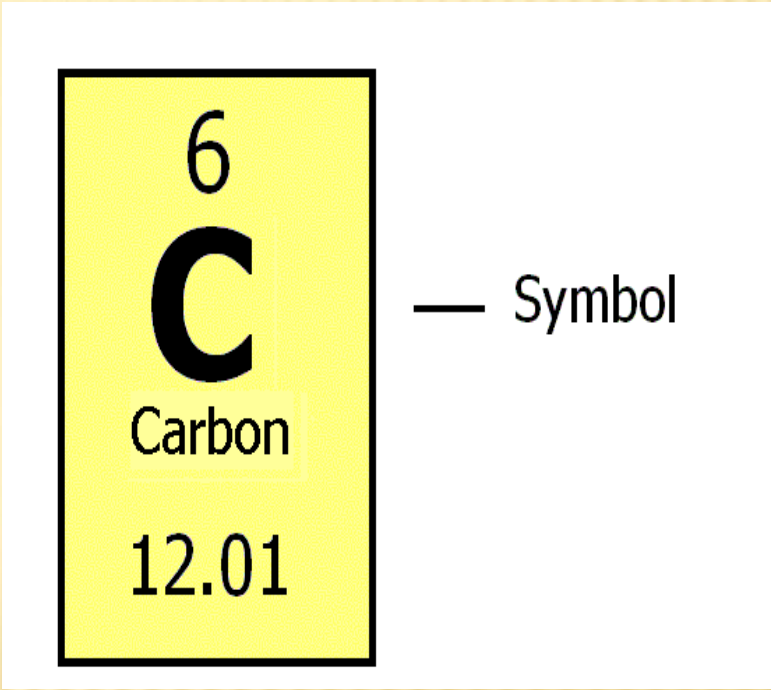


Atomic Mass Unit (amu)

- metric unit to measure the mass of very small objects (particles)
- *a unit to measure the mass of atoms*

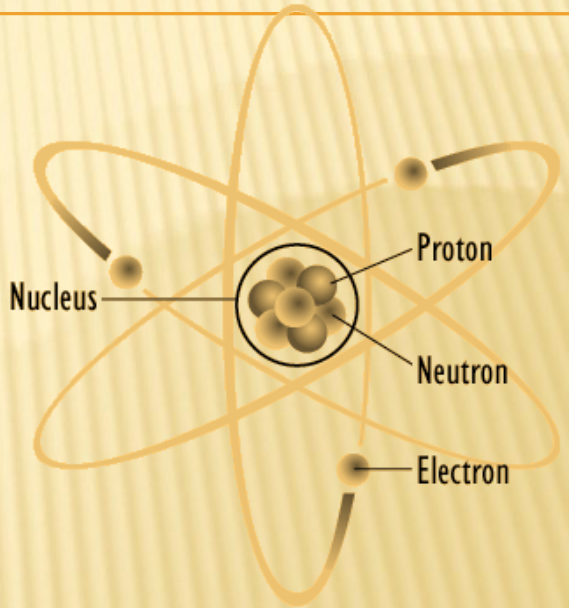
THE SYMBOL?

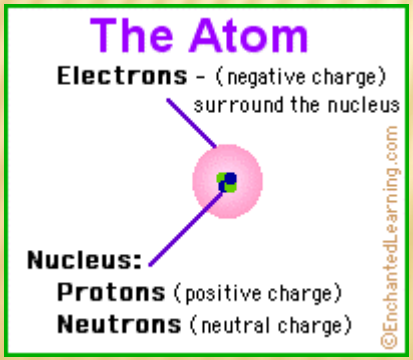
An abbreviation of the element name.

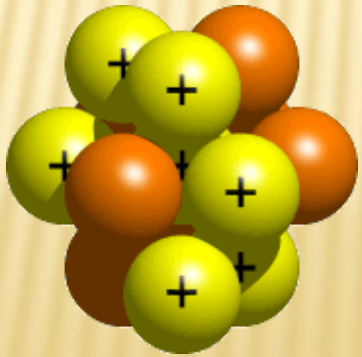


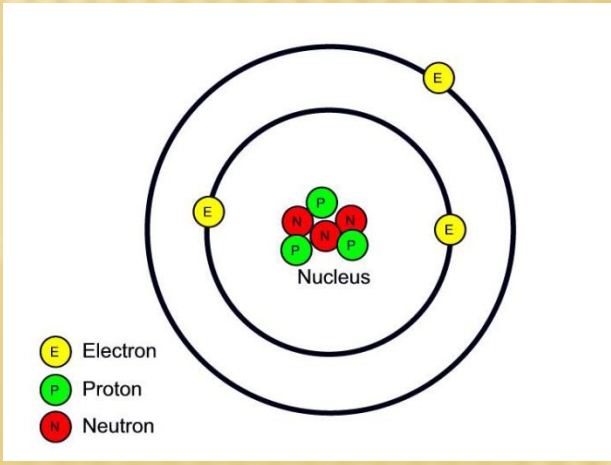
THE NUCLEUS?

- small, dense center of atom
- contains almost all the mass of the atom
- contains protons and neutrons
- The central part of an atom.
- Contains most of an atom's mass.





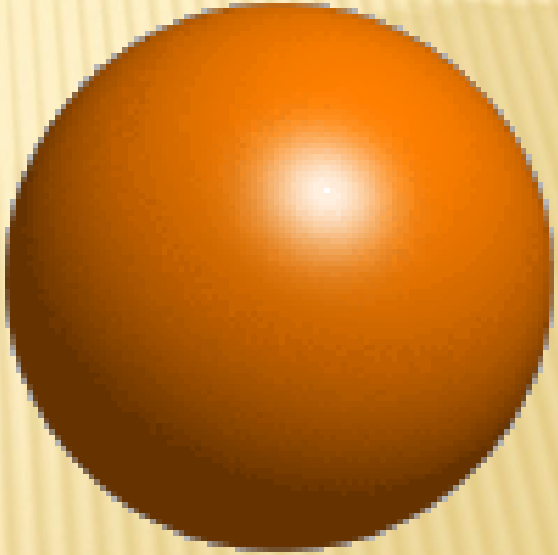




A NEUTRON?

Uncharged particle.

Found within an atomic nucleus.



AN ELECTRON?

Negatively charged particle.

Located in shells that surround an atom's nucleus.

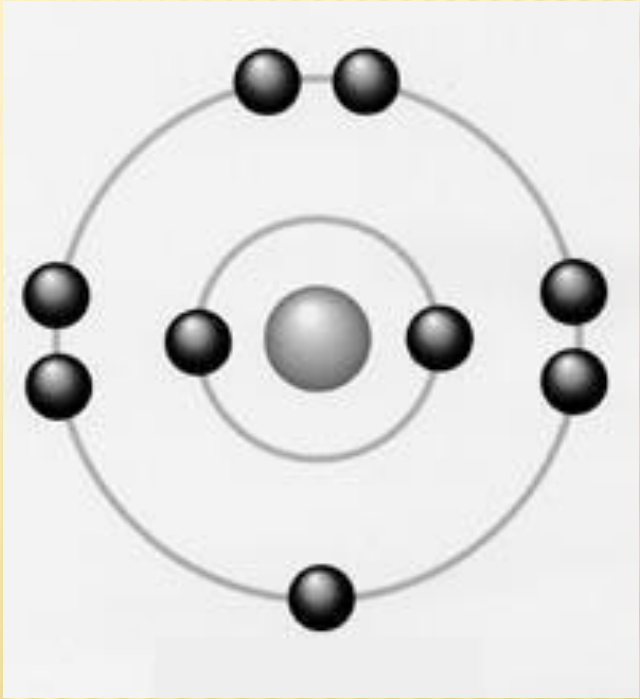
electrons

- **atoms are neutral**
- (+) = (-)
- # of protons = # of electrons
- $p = e^-$

Valence Electrons

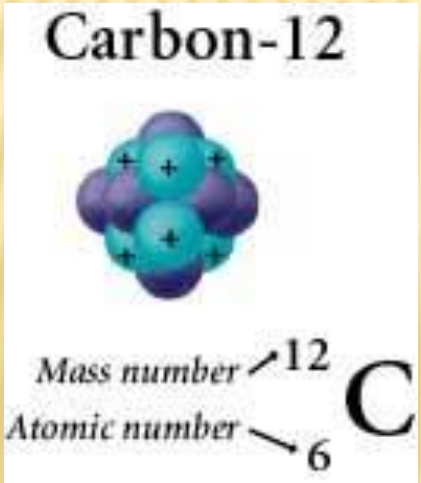
The Valence electrons are the electrons in the outer energy level of an atom.

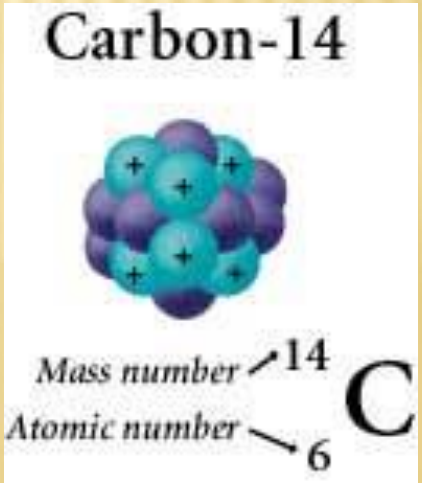
These are the electrons that are transferred or shared when atoms bond together.

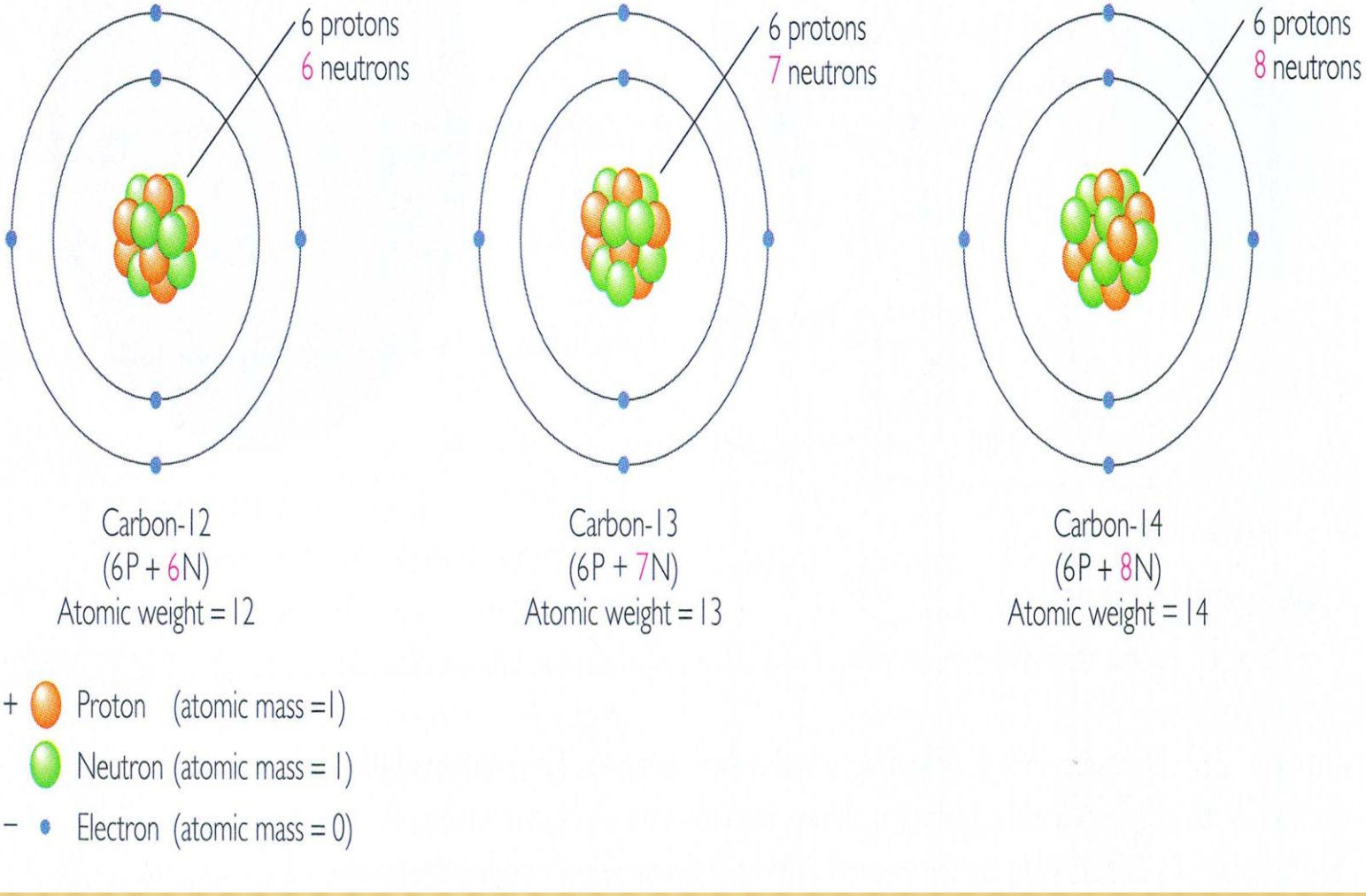


Isotopes

- *iso = same*
- atoms of the **same element** with different numbers of neutrons
- have different atomic masses but the same atomic number
- some are stable, some are radioactive *(carbon-12 and carbon-14)*





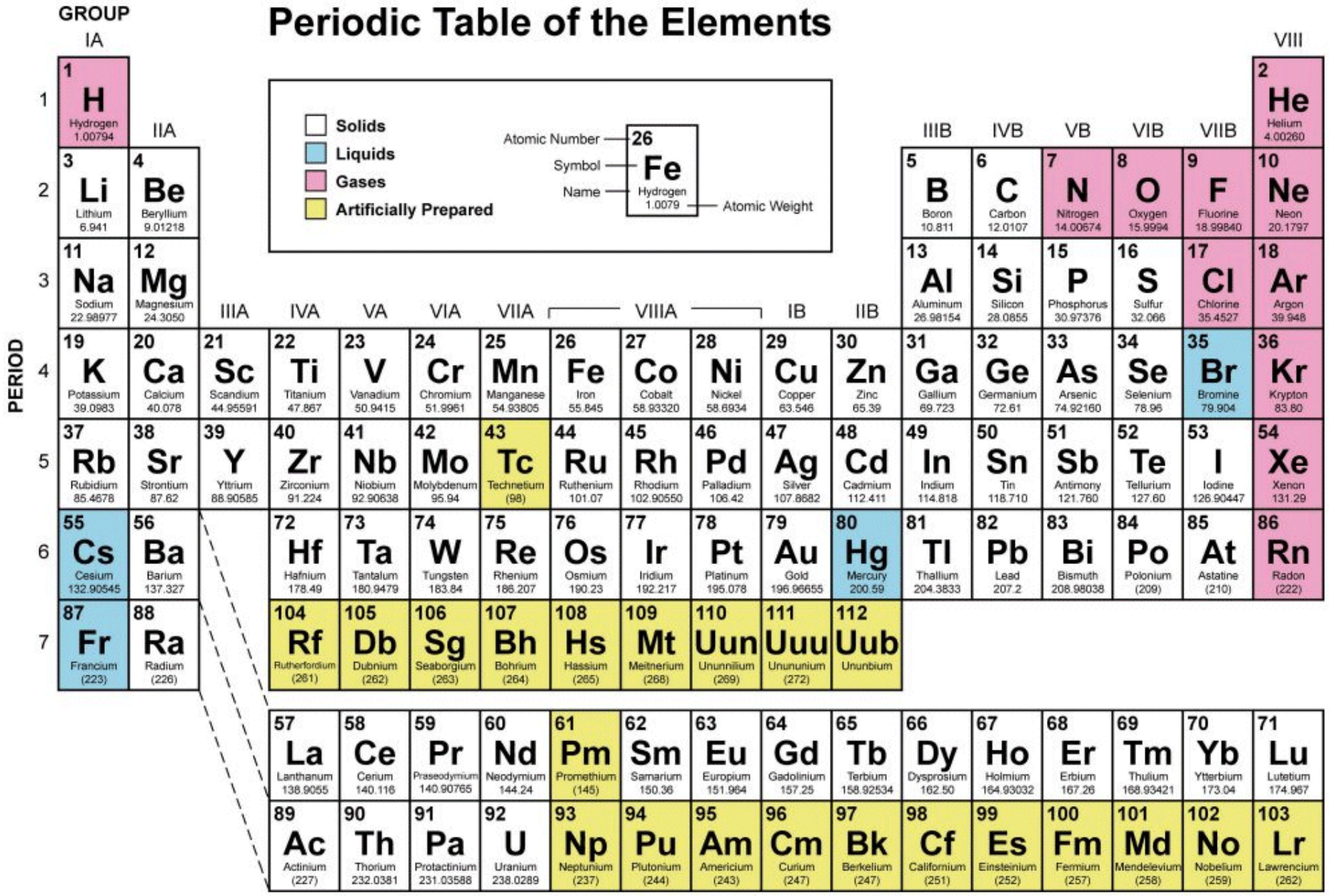

6 protons
6 neutrons
Carbon-12
(6P + 6N)
Atomic weight = 12
6 protons
7 neutrons
Carbon-13
(6P + 7N)
Atomic weight = 13
6 protons
8 neutrons
Carbon-14
(6P + 8N)
Atomic weight = 14
+ Proton (atomic mass = 1)
Neutron (atomic mass = 1)
− Electron (atomic mass = 0)

PERIODIC TABLE

- How is the periodic table arranged?
  - arranged by increasing atomic number

rows

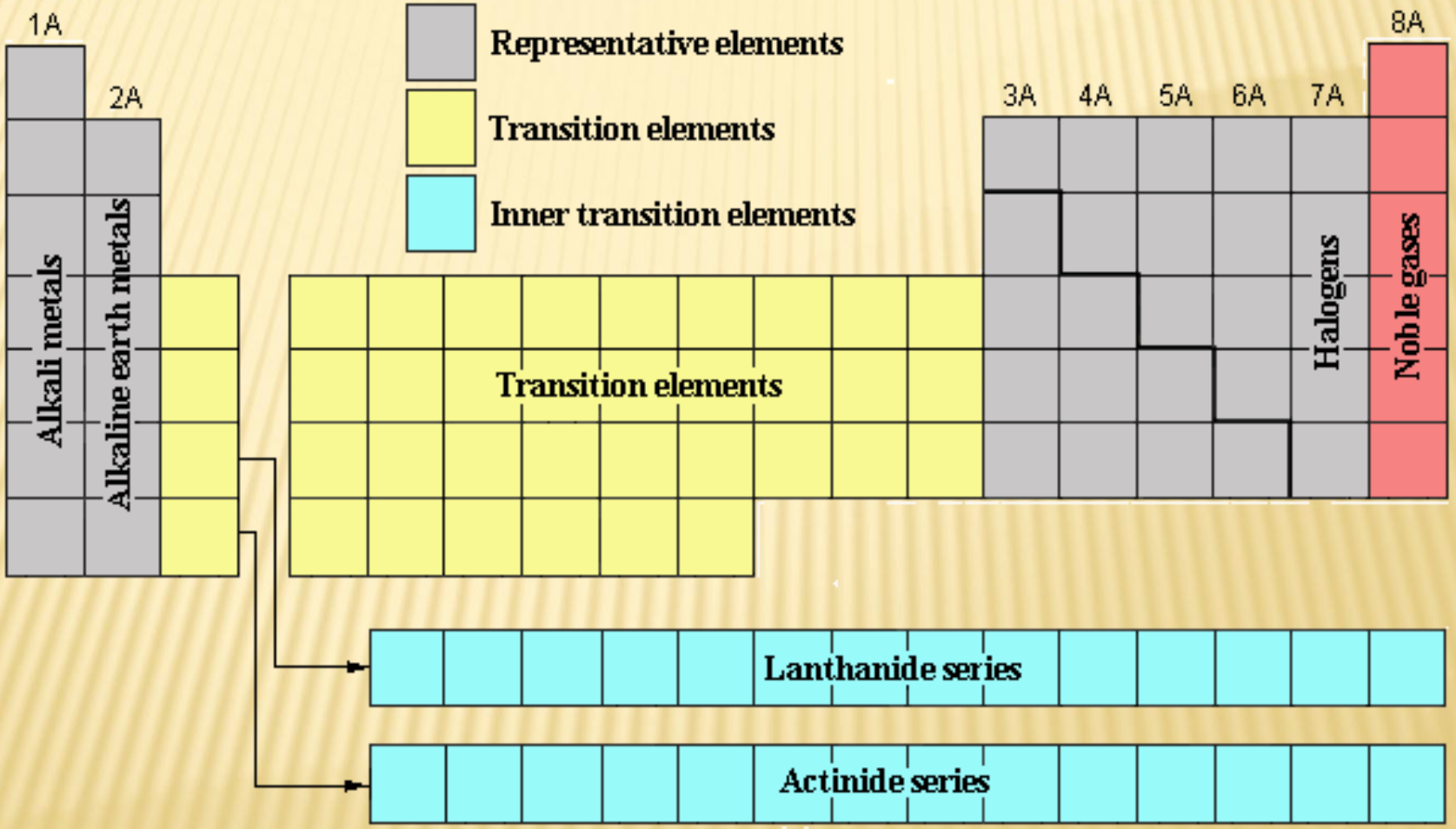
- called periods
- tells number of electron shells
- *number them down the left side of the periodic table – 1 through 7*


GROUP
IA
IIA
IIIA
IVA
VA
VIA
VIIA
VIIIA
IB
IIB
IIIB
IVB
VB
VIB
VIIB
VIII
PERIOD
Periodic Table of the Elements
Solids
Liquids
Gases
Artificially Prepared
Atomic Number
Symbol
Name
Atomic Weight
26
Fe
Hydrogen
1.0079
1 H Hydrogen 1.00794
2 He Helium 4.00260
3 Li Lithium 6.941
4 Be Beryllium 9.01218
5 B Boron 10.811
6 C Carbon 12.0107
7 N Nitrogen 14.00674
8 O Oxygen 15.9994
9 F Fluorine 18.99840
10 Ne Neon 20.1797
11 Na Sodium 22.98977
12 Mg Magnesium 24.3050
13 Al Aluminum 26.98154
14 Si Silicon 28.0855
15 P Phosphorus 30.97376
16 S Sulfur 32.066
17 Cl Chlorine 35.4527
18 Ar Argon 39.948
19 K Potassium 39.0983
20 Ca Calcium 40.078
21 Sc Scandium 44.95591
22 Ti Titanium 47.867
23 V Vanadium 50.9415
24 Cr Chromium 51.9961
25 Mn Manganese 54.93805
26 Fe Iron 55.845
27 Co Cobalt 58.93320
28 Ni Nickel 58.6934
29 Cu Copper 63.546
30 Zn Zinc 65.39
31 Ga Gallium 69.723
32 Ge Germanium 72.61
33 As Arsenic 74.92160
34 Se Selenium 78.96
35 Br Bromine 79.904
36 Kr Krypton 83.80
37 Rb Rubidium 85.4678
38 Sr Strontium 87.62
39 Y Yttrium 88.90585
40 Zr Zirconium 91.224
41 Nb Niobium 92.90638
42 Mo Molybdenum 95.94
43 Tc Technetium (98)
44 Ru Ruthenium 101.07
45 Rh Rhodium 102.90550
46 Pd Palladium 106.42
47 Ag Silver 107.8682
48 Cd Cadmium 112.411
49 In Indium 114.818
50 Sn Tin 118.710
51 Sb Antimony 121.760
52 Te Tellurium 127.60
53 I Iodine 126.90447
54 Xe Xenon 131.29
55 Cs Cesium 132.90545
56 Ba Barium 137.327
72 Hf Hafnium 178.49
73 Ta Tantalum 180.9479
74 W Tungsten 183.84
75 Re Rhenium 186.207
76 Os Osmium 190.23
77 Ir Iridium 192.217
78 Pt Platinum 195.078
79 Au Gold 196.96655
80 Hg Mercury 200.59
81 Tl Thallium 204.3833
82 Pb Lead 207.2
83 Bi Bismuth 208.98038
84 Po Polonium (209)
85 At Astatine (210)
86 Rn Radon (222)
87 Fr Francium (223)
88 Ra Radium (226)
104 Rf Rutherfordium (261)
105 Db Dubnium (262)
106 Sg Seaborgium (263)
107 Bh Bohrium (264)
108 Hs Hassium (265)
109 Mt Meitnerium (268)
110 Uun Ununnilium (269)
111 Uuu Unununium (272)
112 Uub Ununbium
57 La Lanthanum 138.9055
58 Ce Cerium 140.116
59 Pr Praseodymium 140.90765
60 Nd Neodymium 144.24
61 Pm Promethium (145)
62 Sm Samarium 150.36
63 Eu Europium 151.964
64 Gd Gadolinium 157.25
65 Tb Terbium 158.92534
66 Dy Dysprosium 162.50
67 Ho Holmium 164.93032
68 Er Erbium 167.26
69 Tm Thulium 168.93421
70 Yb Ytterbium 173.04
71 Lu Lutetium 174.967
89 Ac Actinium (227)
90 Th Thorium 232.0381
91 Pa Protactinium 231.03588
92 U Uranium 238.0289
93 Np Neptunium (237)
94 Pu Plutonium (244)
95 Am Americium (243)
96 Cm Curium (247)
97 Bk Berkelium (247)
98 Cf Californium (251)
99 Es Einsteinium (252)
100 Fm Fermium (257)
101 Md Mendelevium (258)
102 No Nobelium (259)
103 Lr Lawrencium (262)

PERIODIC TABLE

columns

- called families or groups
- elements in same column have similar chemical properties
- same number of valence electrons


1A
2A
3A
4A
5A
6A
7A
8A
Representative elements
Transition elements
Inner transition elements
Alkali metals
Alkaline earth metals
Transition elements
Halogens
Noble gases
Lanthanide series
Actinide series

STABILITY

- stable number of electrons = 8 in the outermost shell
  - 8 valence e^-
  - octet rule

- exception – 1st shell is stable with 2 e^-

METALS

- 1 to 3 valence electrons
- givers of electrons
- lose electrons
- make (+) ions
- left side of periodic table

NONMETALS

- 5 to 8 valence electrons
- takers of electrons
- gain electrons
- make (-) ions
- right side of periodic table

PROPERTIES OF METALS & NON-METALS

Metals	Non-metals
Mostly solid	**Can be solid, liquid or gas**
Have shiny appearance	**Have dull appearance**
Good conductors of heat & electricity	**Poor conductors of heat & electricity**
Malleable & ductile	**Brittle (if solid)**
Lose electrons	**share electrons**

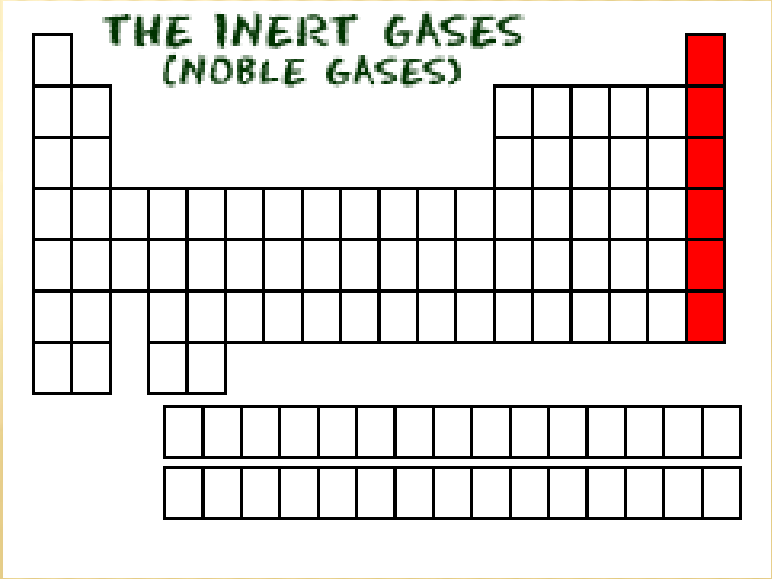
ION

- atom with a charge
- atom has gained or lost electrons
- gained e^- = (-) charge
- lost e^- = (+) charge
- (+) ion = cation
- (-) ion = anion

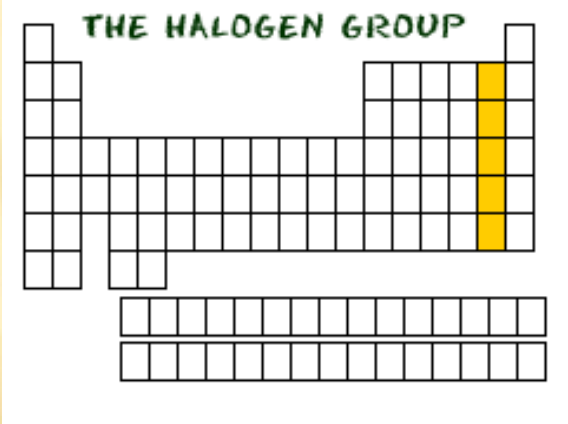
COLUMN 8

Noble gases

- very stable
- don't want to form compounds or bonds

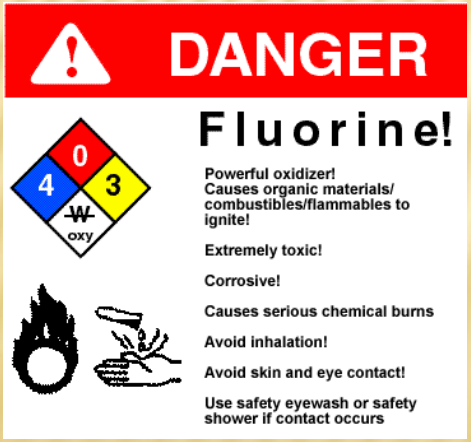


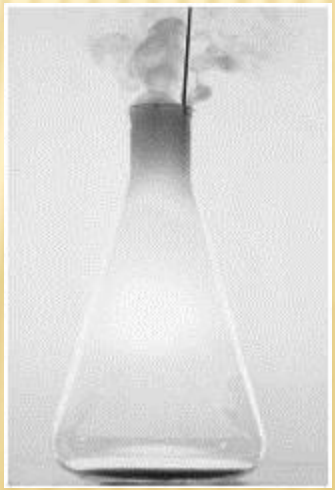
COLUMN 7

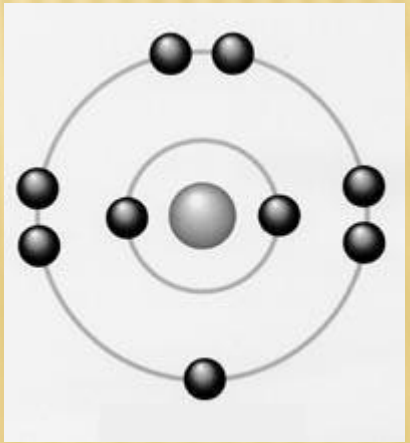


halogens

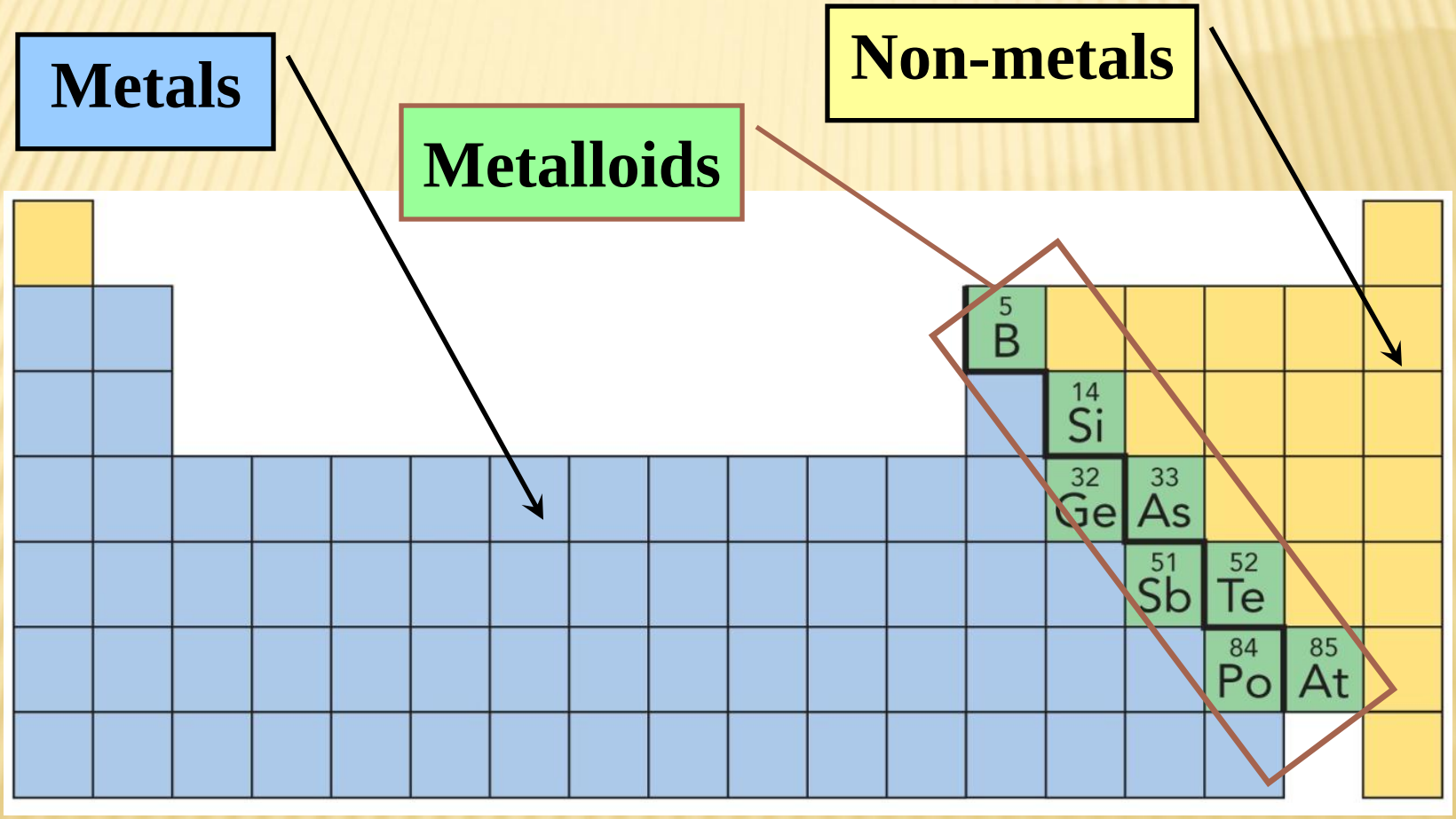
- want one more electron
- most reactive nonmetals
- can take an electron from almost anyone





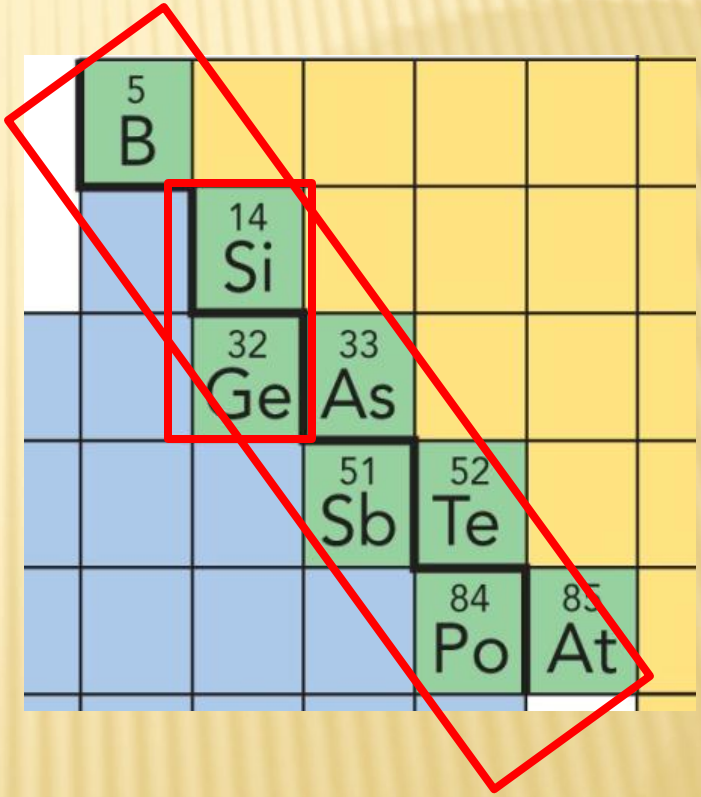


PERIODIC TABLE



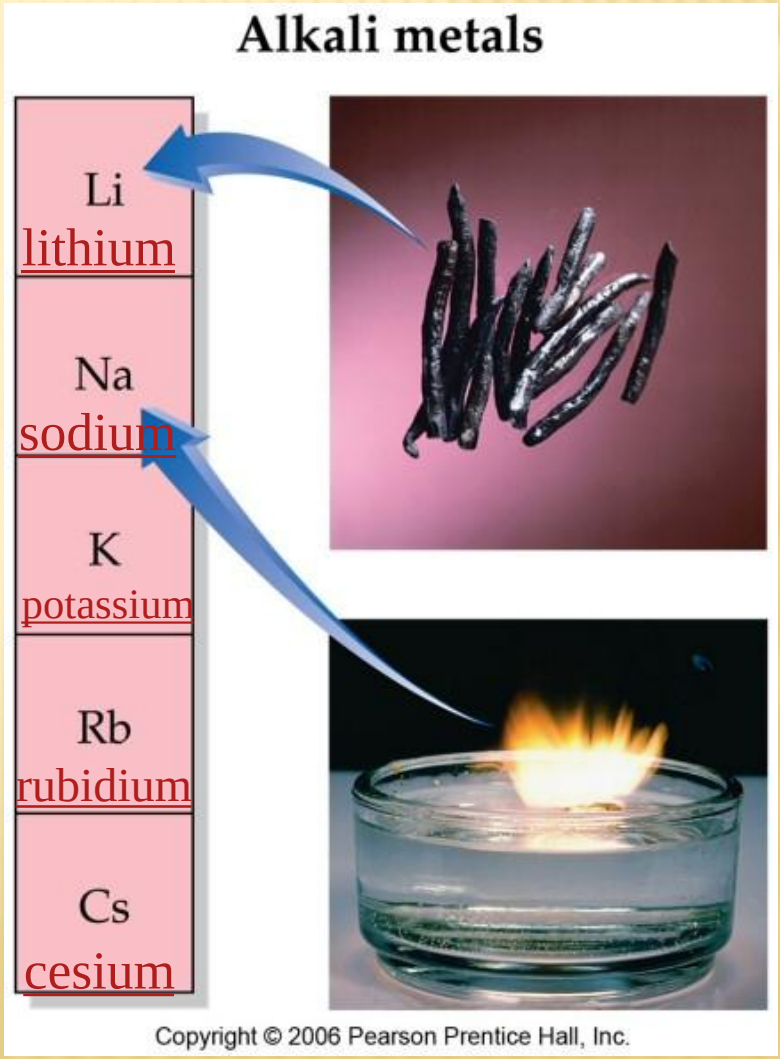
METALLOIDS

- Metalloids are elements that possess some properties of metals and some of non-metals.
- The most important metalloids are silicon (Si) and germanium (Ge) which are used extensively in computer chips.



IMPORTANT GROUPS – IA, ALKALI METALS

- hydrogen usually placed here, though it doesn't belong
- soft, low melting points,low density
- flame tests ® Li = red, Na = yellow, K = violet
- ***very reactive***, never find uncombined in nature
- tend to form water soluble compounds

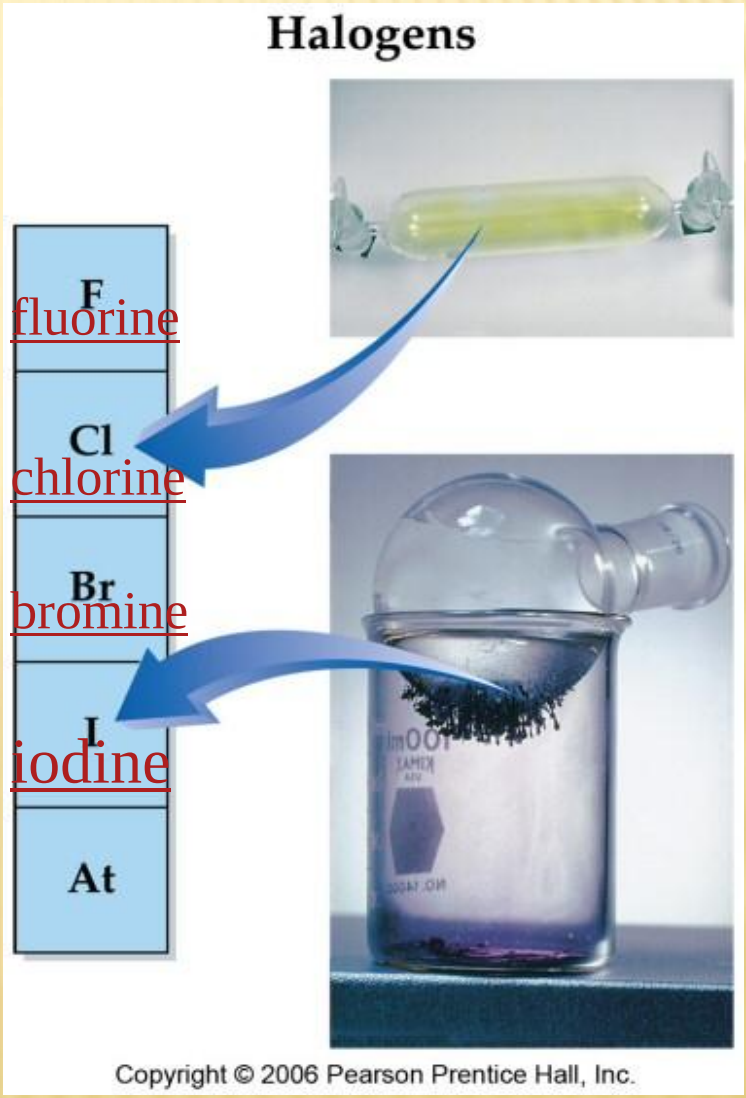


IMPORTANT GROUPS – IIA, ALKALI EARTH METALS

- harder, higher melting, and denser than alkali metals
- flame tests ® Ca = red, Sr = red, Ba = yellow-green
- reactive, but less than corresponding alkali metal
- form stable, insoluble oxides from which they are normally extracted
- oxides are basic = alkaline earth
- reactivity with water to form H_2,

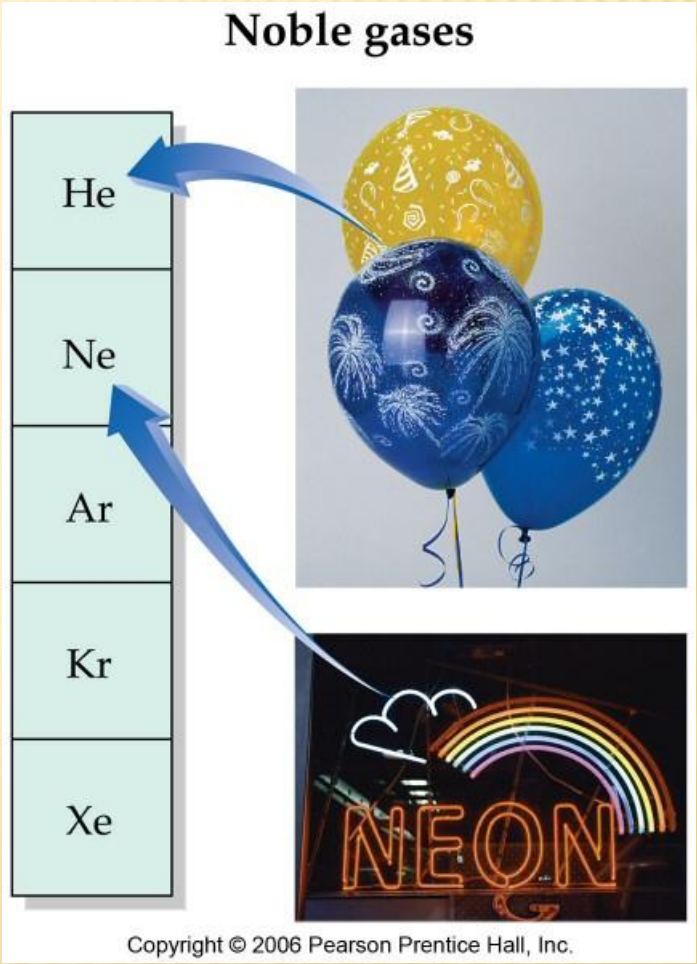
IMPORTANT GROUPS – VIIA, HALOGENS

- nonmetals
- F_2 & Cl_2 gases; Br_2 liquid; I_2 solid
- all diatomic
- very reactive
- react with metals to form ionic compounds
- HX (X = halogen) are all acids
  - HF weak < HCl < HBr < HI



IMPORTANT GROUPS – VIIIA, NOBLE GASES

- all exist as gases at room temperature,
  - very low melting and boiling points
- very unreactive, practically inert
- very hard to remove electron or add an electron



Thank you for listening