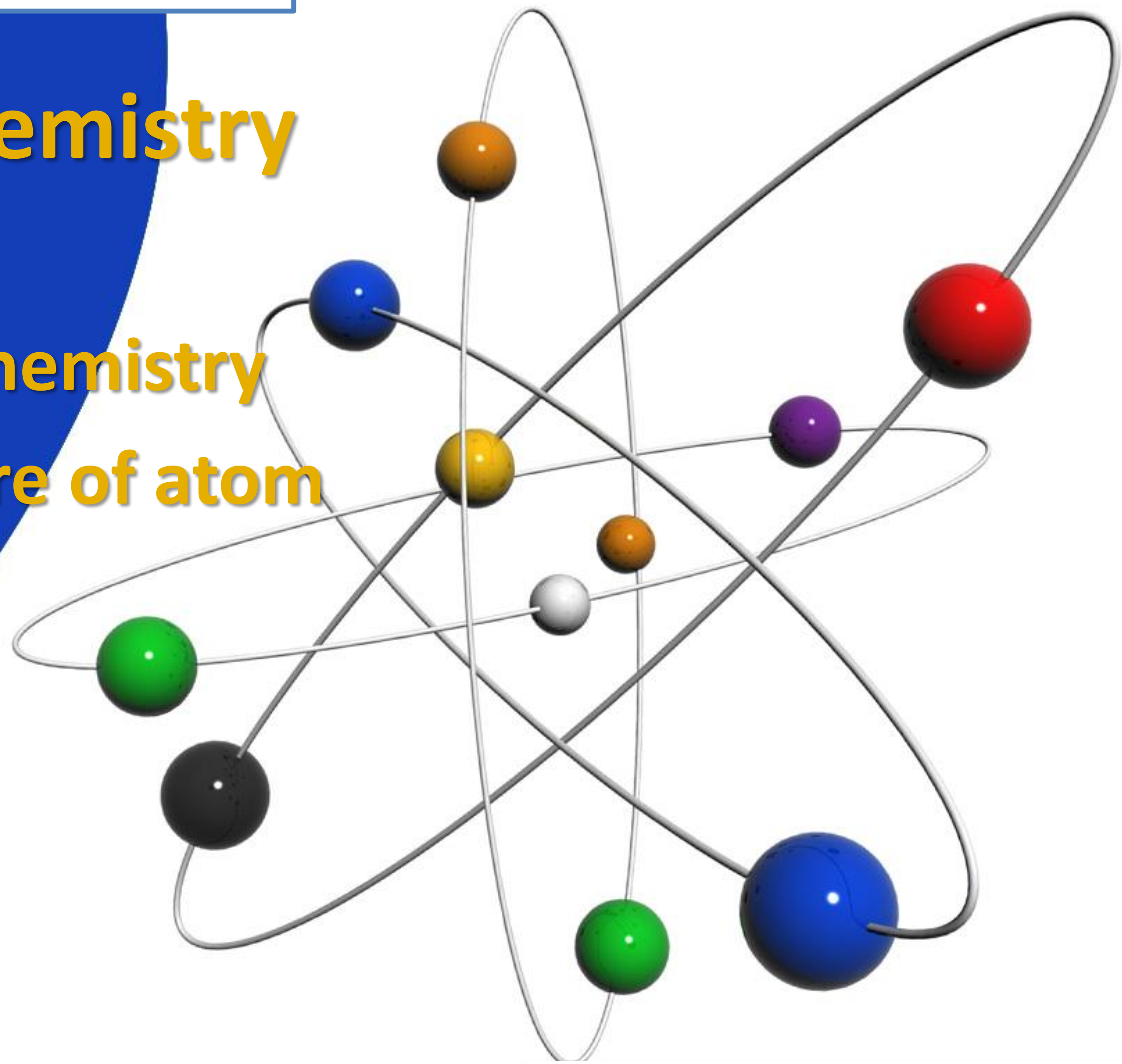
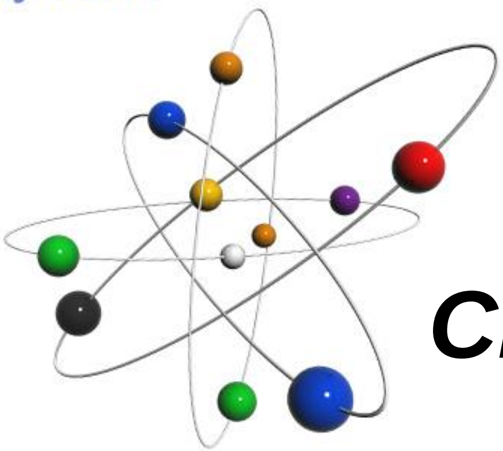
The first lecture

- **General chemistry**
- **1-Chemistry**
- **2-Branch of chemistry**
- **3-The structure of atom**



عداد :أ.م.د.سماء عدنان رؤوف



Chemistry

Is the science that deals

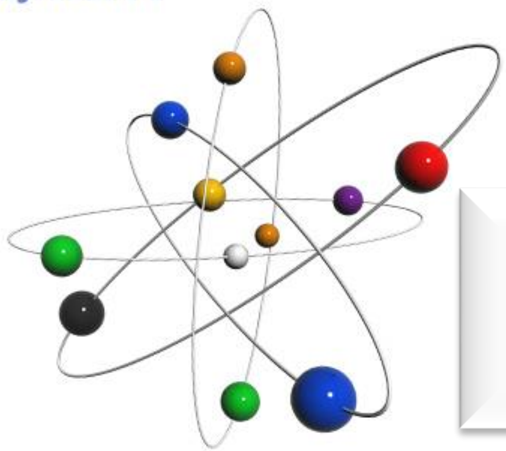
with elements and compounds composed

of atoms, molecules and ions:

their composition, structure, properties,

behavior and the changes they undergo

during a reaction with other substances.

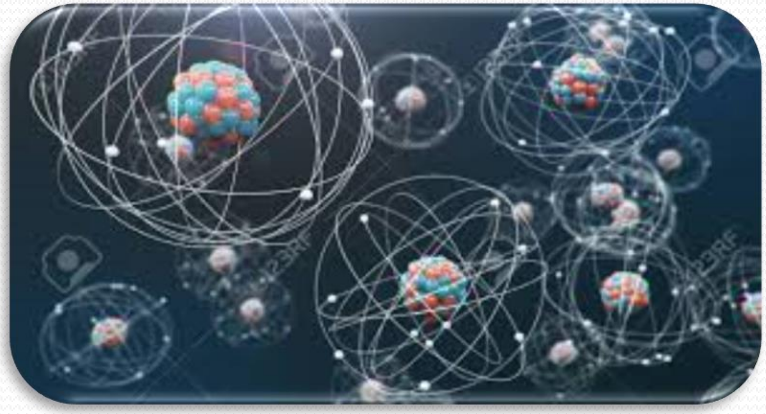


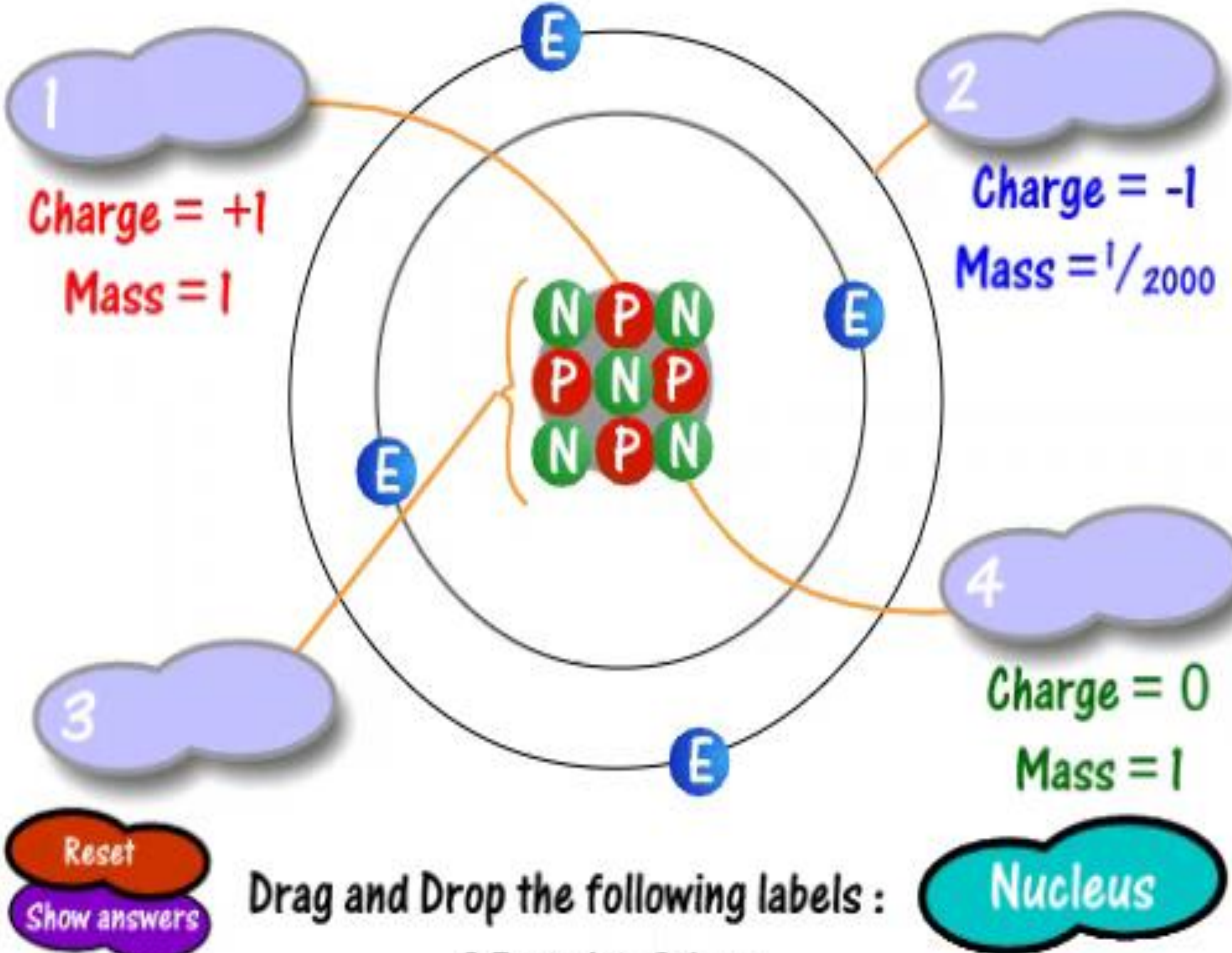
Branchs of chemistry

- 1-***Organic chemistry***: study properties, reaction &preparation of carbon compounds.
- 2-***Physical chemistry***: study electrochemical, kinetic thermodynamic reaction.
- 3-***Analytical chemistry***:study quantitative & qualitative analysis.
- 4-***Biochemistry***: study the chemical reaction inside the tissue of human body.
- 5-***Inorganic chemistry***: study the periodic table &it's chemical behavior.

The structure of atom

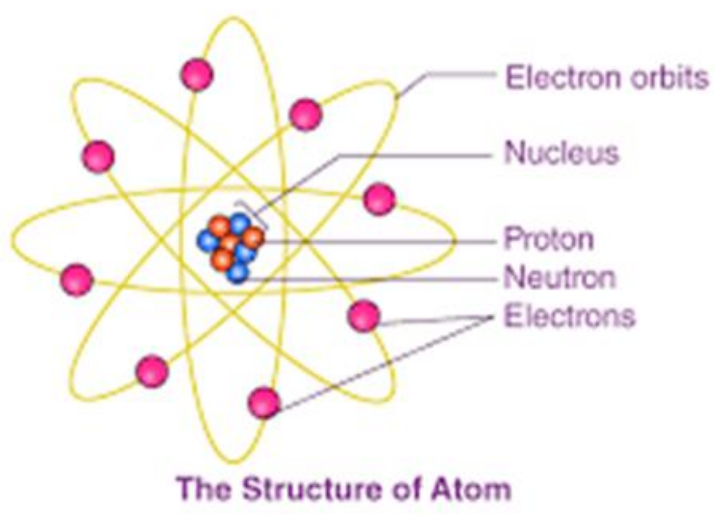
- ***The Atom***: the smallest particle in element having the properties of that element ,it's consist of positive nuclei surrounded by negatively charged electrons.
- Nucleus consist of protons and neutrons together





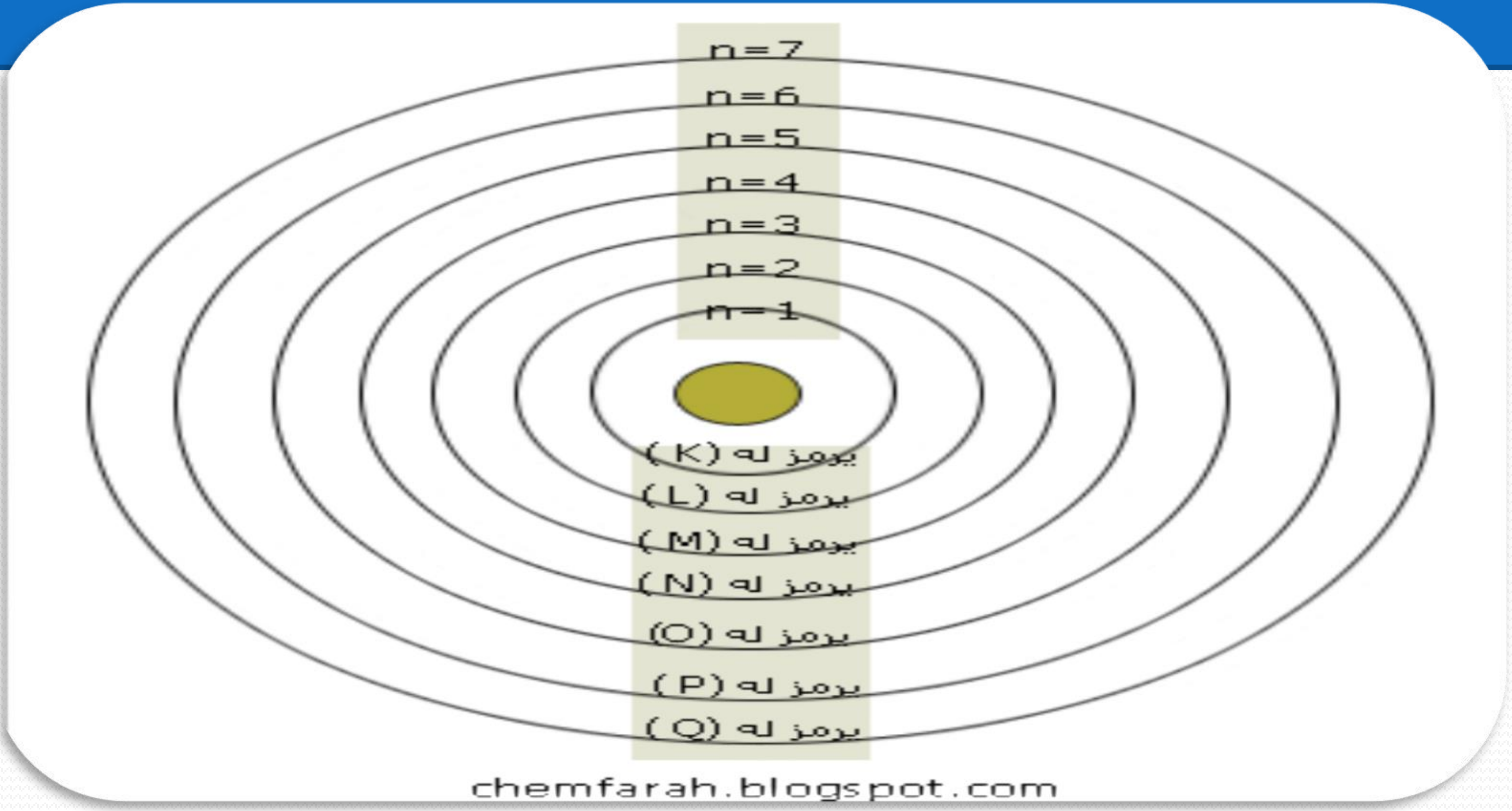
1
Charge = +1
Mass = 1
E
2
Charge = -1
Mass = 1/2000
N P N
P N P
N P N
E
E
4
3
Charge = 0
Mass = 1
E
Reset
Show answers
Drag and Drop the following labels :
Nucleus

- The atomic number: it is the number of the positive charges protons in the nucleus. Which is always equal to the number of negative charges electrons in the neutral atom .



- For identification, each one of these energy levels take aletter and anumber called principal quantum number (n) describes the energy of an electron and the most probable distance of the electron from the nucleus., the first shell take the letter(K) and the (n),equal to(1),this shell is of the lower energy
- Schematic representation of energy levels around the nucleus of the atome

The maximum number of electrons that can occupy a shell is equal to $2(n)^2$. Thus for the(k) shell in which (n=1),the maximum number of electrons equal $2(1)^2 =2$) elec.for the(L) shell in which the maximum number of elec.is $2(2)^2=8$ elec. And so on.



- n=principal quantum number

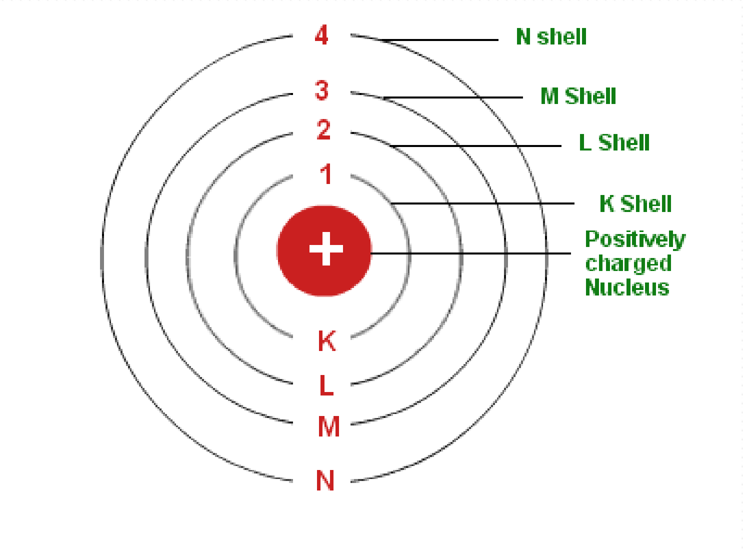
L,

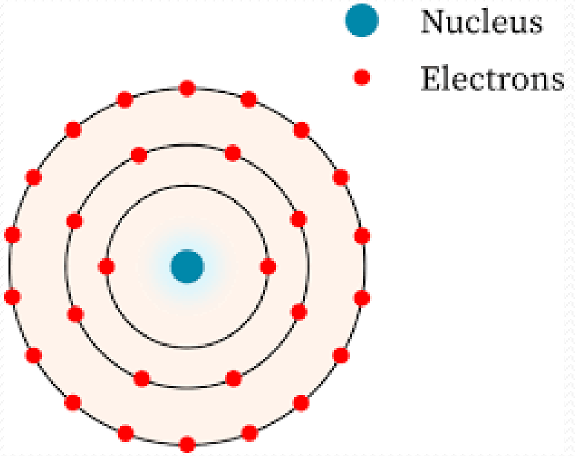
n=2,

$2(n)^2$

=2*4

=8





M, n=3 $,2(3)^2 = 2(9) = 18$

Filling of the orbitals:

Name of shell	***P.Q.Number(n)***	***Max.No.of elect*.**
K	**1**	**2**
L	**2**	**8**
M	**3**	**18**
N	**4**	**32**
O	**5**	**50**
P	**6**	**72**
Q	**7**	**98**

Table 8.3 Partial Orbital Diagrams and Electron Configurations* for the Elements in Period 3

Atomic Number/ Element	Partial Orbital Diagram (3*s* and 3*p* Sublevels Only) 3*s*	3*p*			Full Electron Configuration	Condensed Electron Configuration
11/Na	↑				$[1s^2 2s^2 2p^6]\ 3s^1$	$[Ne]\ 3s^1$
12/Mg	↑↓				$[1s^2 2s^2 2p^6]\ 3s^2$	$[Ne]\ 3s^2$
13/Al	↑↓	↑			$[1s^2 2s^2 2p^6]\ 3s^2 3p^1$	$[Ne]\ 3s^2 3p^1$
14/Si	↑↓	↑	↑		$[1s^2 2s^2 2p^6]\ 3s^2 3p^2$	$[Ne]\ 3s^2 3p^2$
15/P	↑↓	↑	↑	↑	$[1s^2 2s^2 2p^6]\ 3s^2 3p^3$	$[Ne]\ 3s^2 3p^3$
16/S	↑↓	↑↓	↑	↑	$[1s^2 2s^2 2p^6]\ 3s^2 3p^4$	$[Ne]\ 3s^2 3p^4$
17/Cl	↑↓	↑↓	↑↓	↑	$[1s^2 2s^2 2p^6]\ 3s^2 3p^5$	$[Ne]\ 3s^2 3p^5$
18/Ar	↑↓	↑↓	↑↓	↑↓	$[1s^2 2s^2 2p^6]\ 3s^2 3p^6$	$[Ne]\ 3s^2 3p^6$

*Colored type indicates sublevel to which last electron is added.

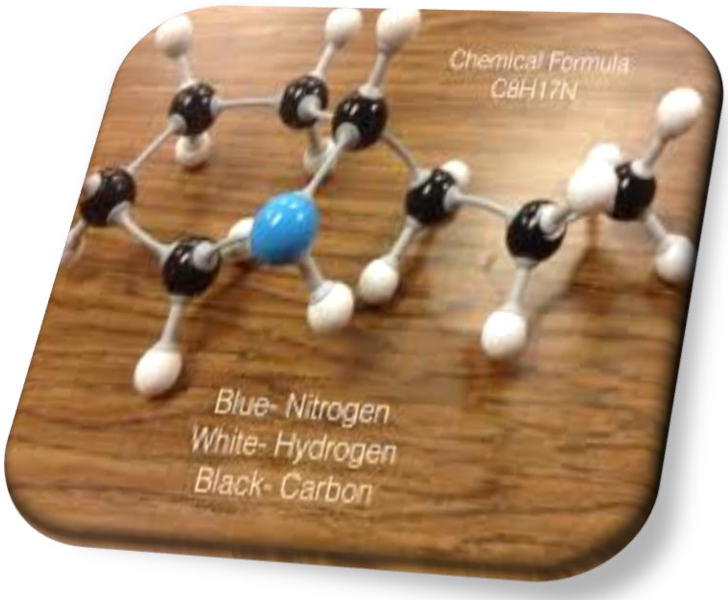
Categories of Electrons

Inner (core) electrons: fill all the *lower* energy levels of an atom

Outer electrons: those electrons in the *highest* energy level(highest *n* value) of an atom

Valence electrons: those involved in forming compounds; the bonding electrons; among the main-group elements, the valence electrons are the outer electrons

Lecture:2



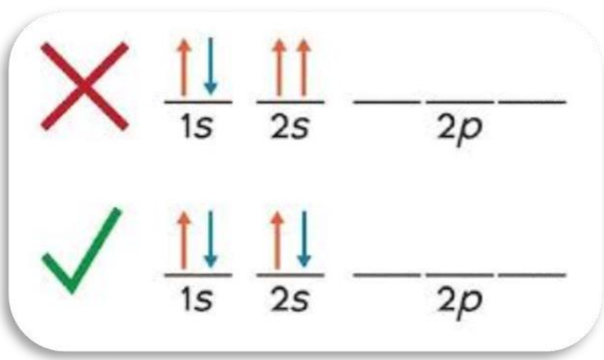
1-THE ELECTRONIC CONFIGURATION

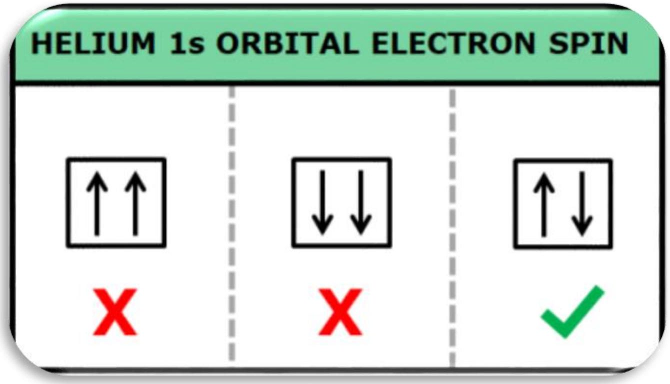
2-Peroiodic table

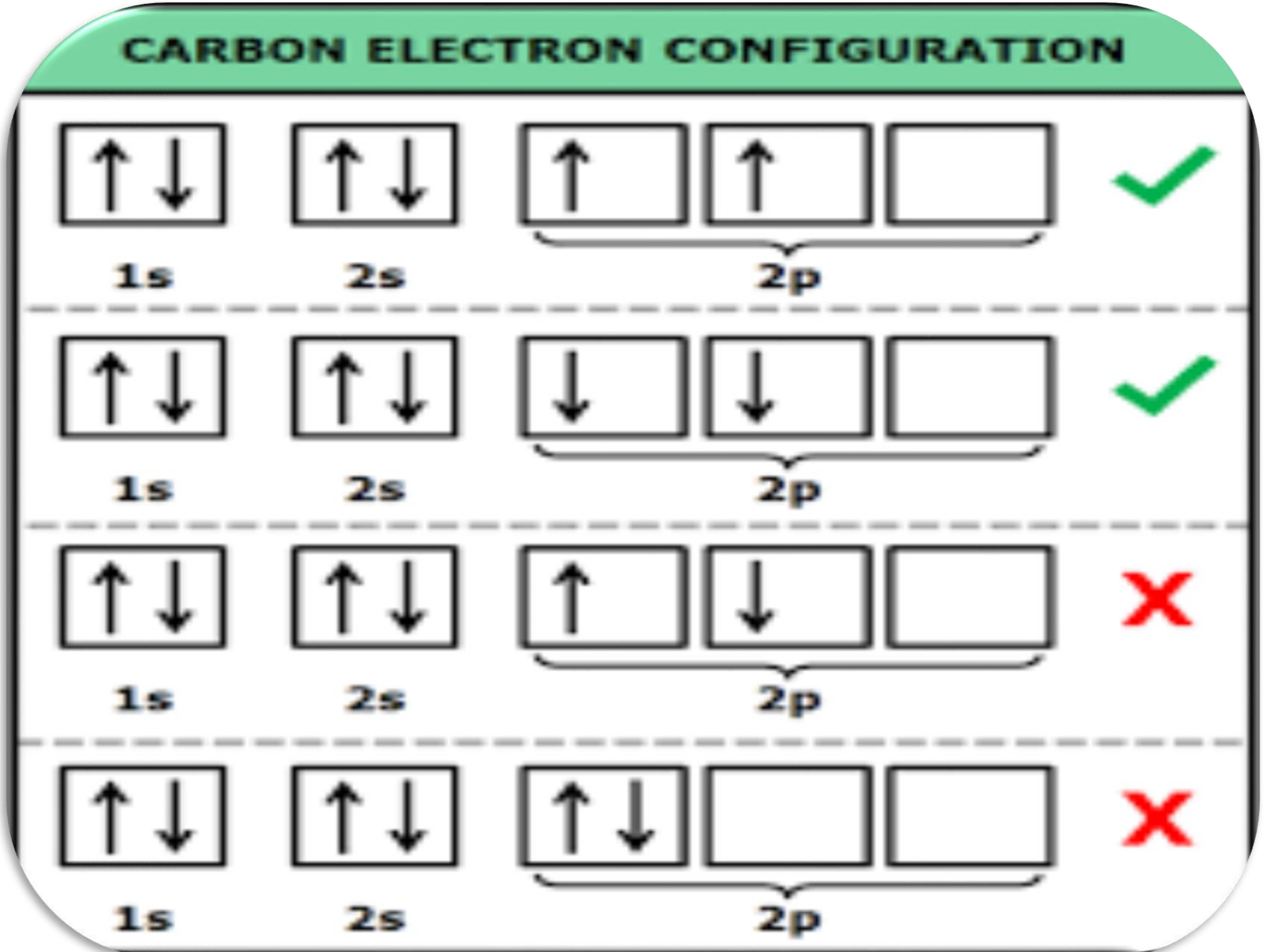
THE ELECTRONIC CONFIGURATION:

The question of how many electrons can occupy given orbital is answered by Pauli's exclusion principle which state that no more than two electrons occupy the same orbital, and that the spins of these two electrons must be of opposite direction (clock wise or counter clock wise).

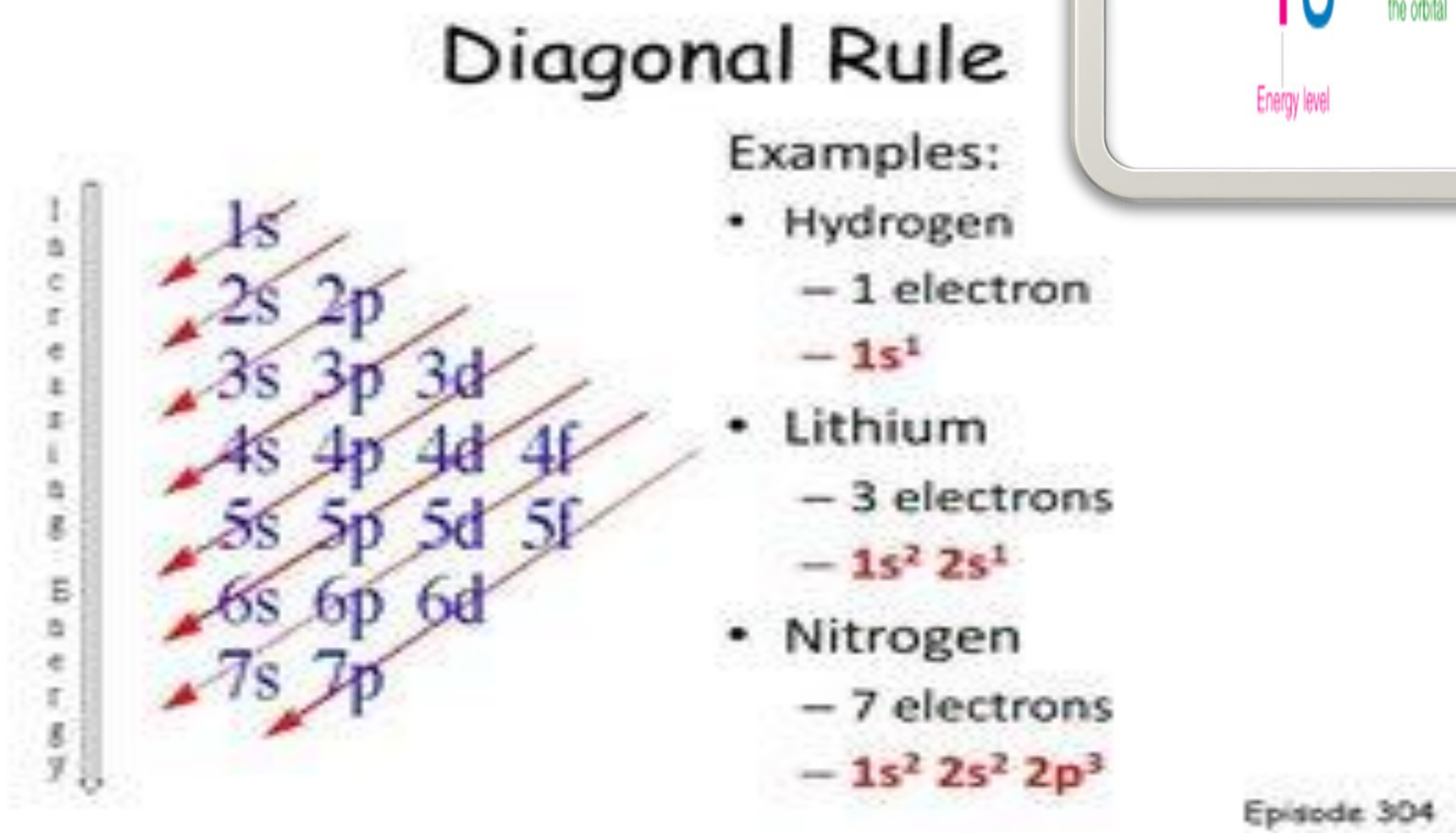
Electrons with antiparallel spins are represented arrows pointing in opposite directions .







CARBON ELECTRON CONFIGURATION
1s
2s
2p
1s
2s
2p
1s
2s
2p
1s
2s
2p


Diagonal Rule
Increasing Energy
1s
2s 2p
3s 3p 3d
4s 4p 4d 4f
5s 5p 5d 5f
6s 6p 6d
7s 7p
Examples:
• Hydrogen
– 1 electron
– $1s^1$
• Lithium
– 3 electrons
– $1s^2\ 2s^1$
• Nitrogen
– 7 electrons
– $1s^2\ 2s^2\ 2p^3$
Episode 304


Type of orbital
$1s^1$
Number of electrone in the orbital
Energy level

ELECTRON CONFIGURATION

$1s^1$

row #
shell #
possibilities are 1-7
7 rows

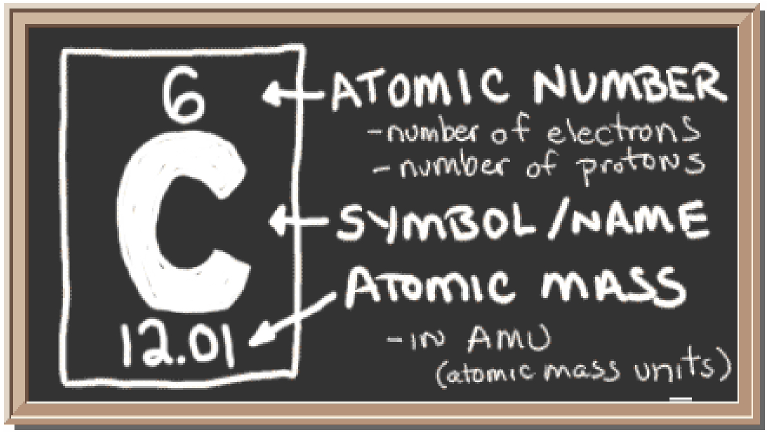
subshell
possibilities are
s, p, d, or f
4 subshells

group #
valence e-
possibilities are:
s: 1 or 2
p: 1-6
d: 1-10
f: 1-14
Total e- should equal
Atomic #

What element has an electron configuration of $1s^1$?

Symbol Atomic no. Electronic Configuratio

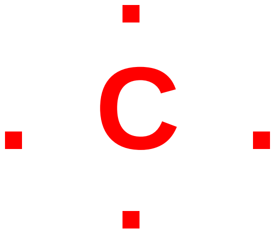
Symbol	Atomic no.	$1s$	$2s$	$2p$			$3s$	Electronic Configuratio
Li	3	↑↓	↑					$1s^2 2s^1$
Be	4	↑↓	↑↓					$1s^2 2s^2$
B	5	↑↓	↑↓	↑				$1s^2 2s^2 2p^1$
C	6	↑↓	↑↓	↑	↑			$1s^2 2s^2 2p^2$
N	7	↑↓	↑↓	↑	↑	↑		$1s^2 2s^2 2p^3$
Ne	10	↑↓	↑↓	↑↓	↑↓	↑↓		$1s^2 2s^2 2p^6$
Na	11	↑↓	↑↓	↑↓	↑↓	↑↓	↑	$1s^2 2s^2 2p^6 3s^1$



Exitation of carbon atom

C_{12}: $1s^2 2s^2 2p^2$

C^*: $1s^2 2s^1 2p^3$

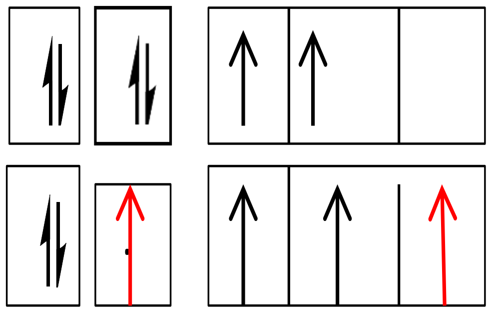


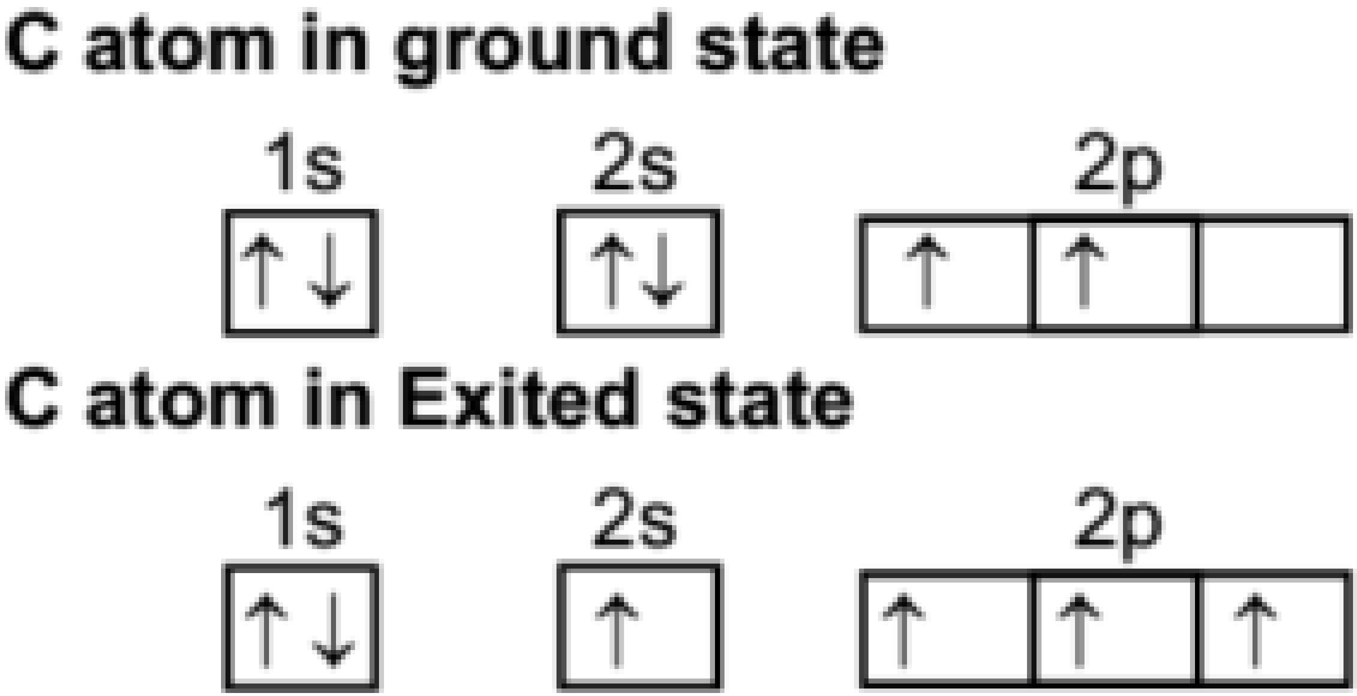
Filling of the orbitals:

Exitation of carbon atom

C_6: $1s^2 2s^2 2p^2$

C^*: $1s^2 2s^1 2p^3$





SAMPLE PROBLEM 8.2 **Determining Electron Configuration**

PROBLEM: **Using the periodic table, give the full and condensed electron configurations, partial orbital diagrams showing valence electrons, and number of inner electrons for the following elements:**

(a) potassium (K: Z = 19) **(b)** molybdenum (Mo: Z = 42) **(c)** lead (Pb: Z = 82)

PLAN: Use the atomic number for the number of electrons and the periodic table for the order of filling of the electron orbitals. Condensed configurations consist of the preceding noble gas plus the outer electrons.

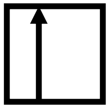
SOLUTION:

(a) for K (Z = 19)

full configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

condensed configuration: [Ar] $4s^1$

partial orbital diagram:



$4s^1$

K has 18 inner electrons.

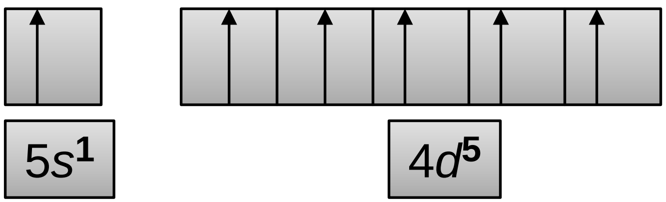
SAMPLE PROBLEM 8.2: (continued)

(b) for Mo (Z = 42)

full configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^1 4d^5$

condensed configuration: [Kr] $5s^1 4d^5$

partial orbital diagram:



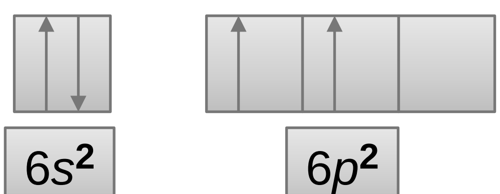
Mo has 36 inner electrons and 6 valence electrons.

(c) for Pb (Z = 82)

full configuration: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^2$

condensed configuration: [Xe] $6s^2 4f^{14} 5d^{10} 6p^2$

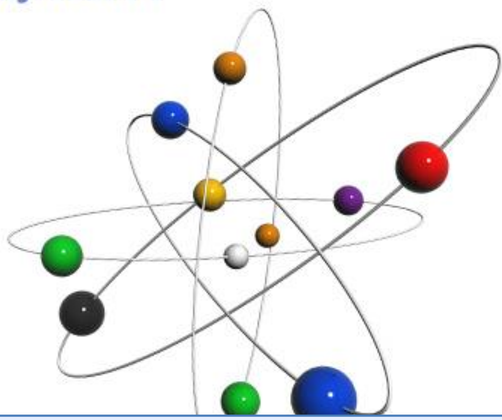
partial orbital diagram:



Pb has 78 inner electrons and 4 valence electrons.

KEY PRINCIPLE

All physical and chemical properties of the elements are based on the <u>electronic configurations</u> of their atoms.



Periodic table

Every element has its own unique symbol For some elements the symbol is simply the first letter of the element's name.

Examples: Hydrogen = H, Sulfur = S, Carbon = C

Symbols for other elements use the first letter plus one other letter of the element's name. The first letter is CAPITALIZED and the second letter is not.

Examples: Aluminum = Al, Platinum = Pt, cadmium = Cd

The origins of some symbols are not as obvious. Some elements have symbols that refer to the element's name in latin.

Examples: gold = Au, lead = Pb, copper = Cu

Periodic table

Periodic Table of the Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VII	VII	VII	IB	IB	IIIA	IVA	VA	VIA	VIIA	0
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	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	32 Ge	33 As	34 Se	35 Br	36 Kr
5	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
6	55 Cs	56 Ba	57 *La	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
7	87 Fr	88 Ra	89 +Ac	104 Rf	105 Ha	106 106	107 107	108 108	109 109	110 110								

* Lanthanide Series	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
+ Actinide Series	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

ما معنى الدورية فى العناصر ؟

أن خواص العناصر الكيميائية والفيزيائية تتكرر عند ترتيب هذه العناصر تصاعديا حسب تزايد اعدادها الذرية بشكلٍ دوري مرة كل ثمانية عناصر .

The Father of the Periodic Table—Dimitri Mendeleev

Mendeleev was the first scientist notice the relationship between the elements,

He Arranged his periodic table by atomic mass

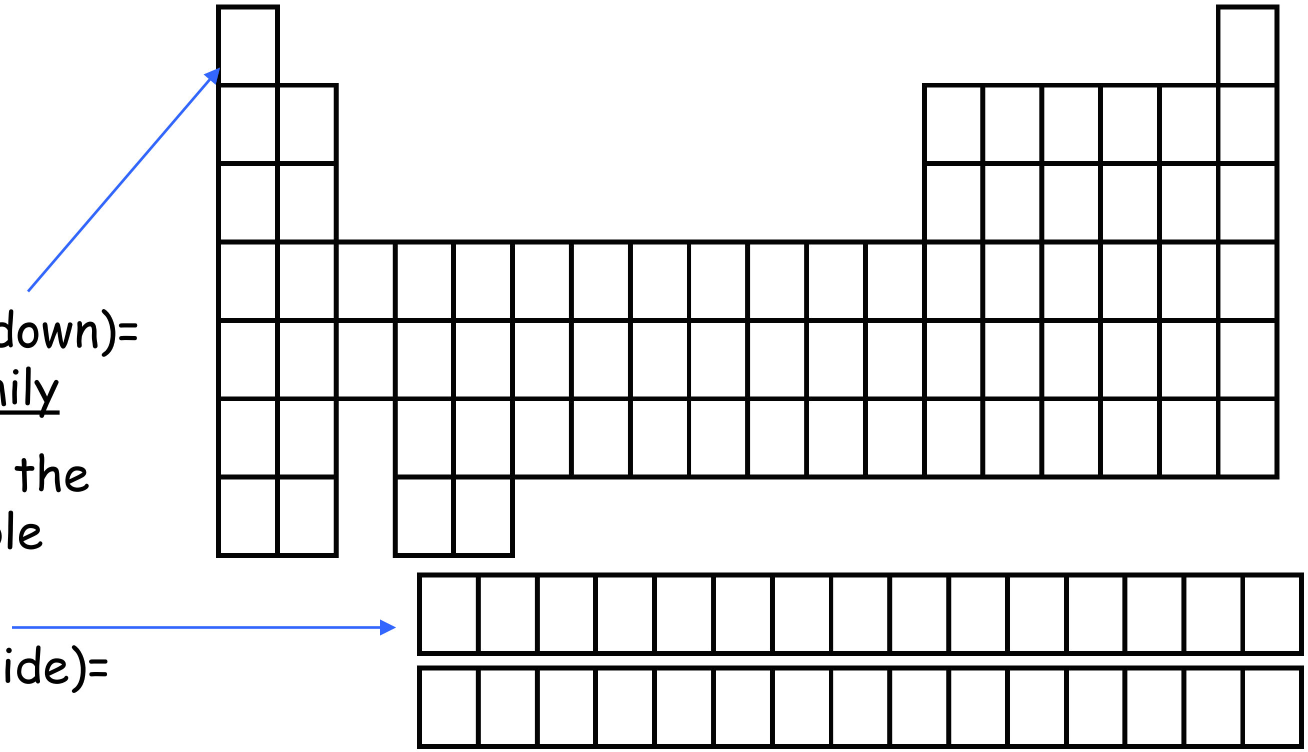
It was later discovered that the periodic nature of the elements was associated with atomic number, not atomic mass

HISTORY OF THE PERIODIC TABLE

1871 – Mendeleev arranged the elements according to: 1. Increasing atomic mass 2. Elements w/ similar properties were put in the same row.

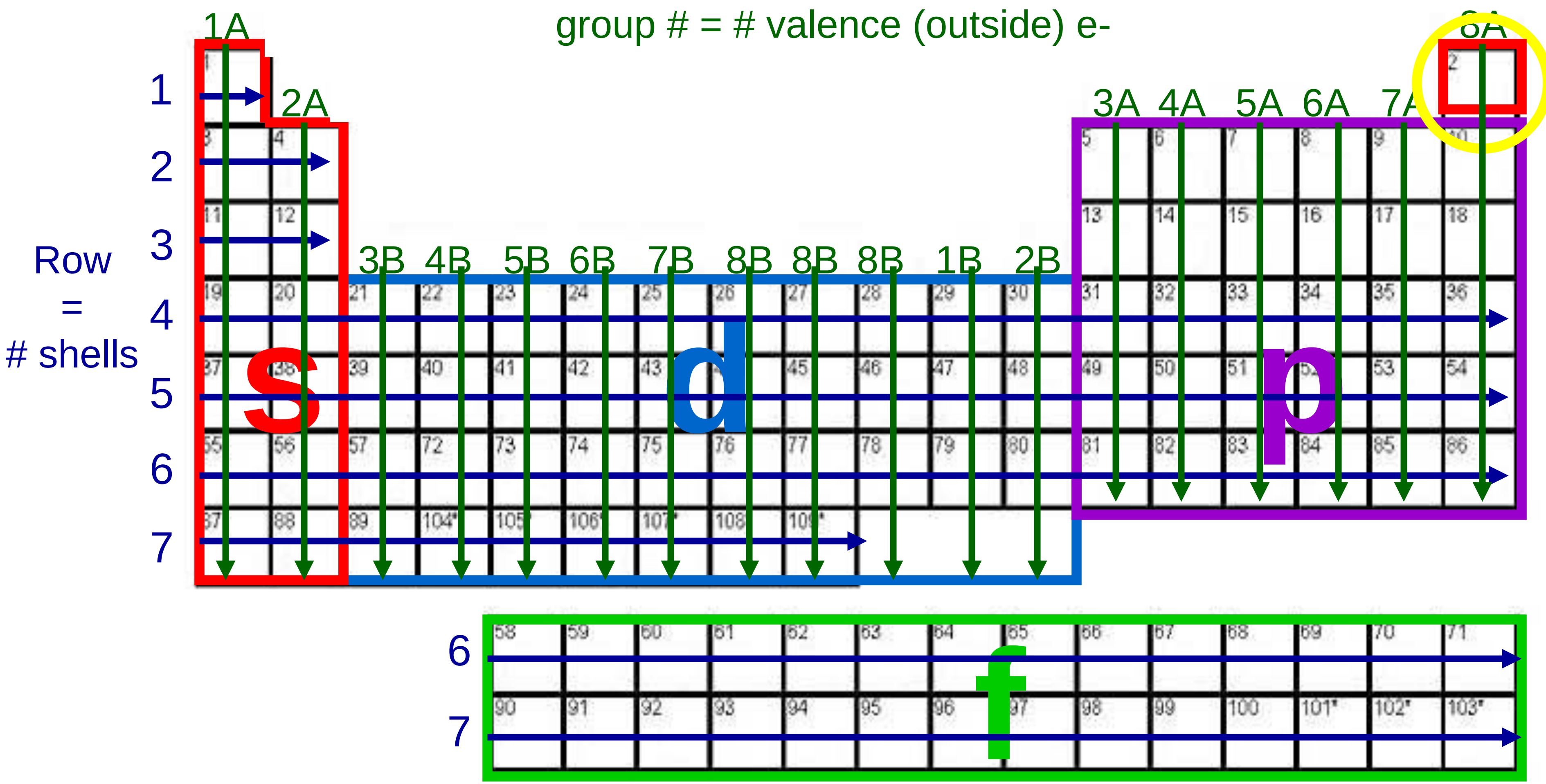
1913 – Moseley arranged the elements according to: 1. Increasing atomic number 2. Elements w/ similar properties were put in the same column.

The Periodic Table



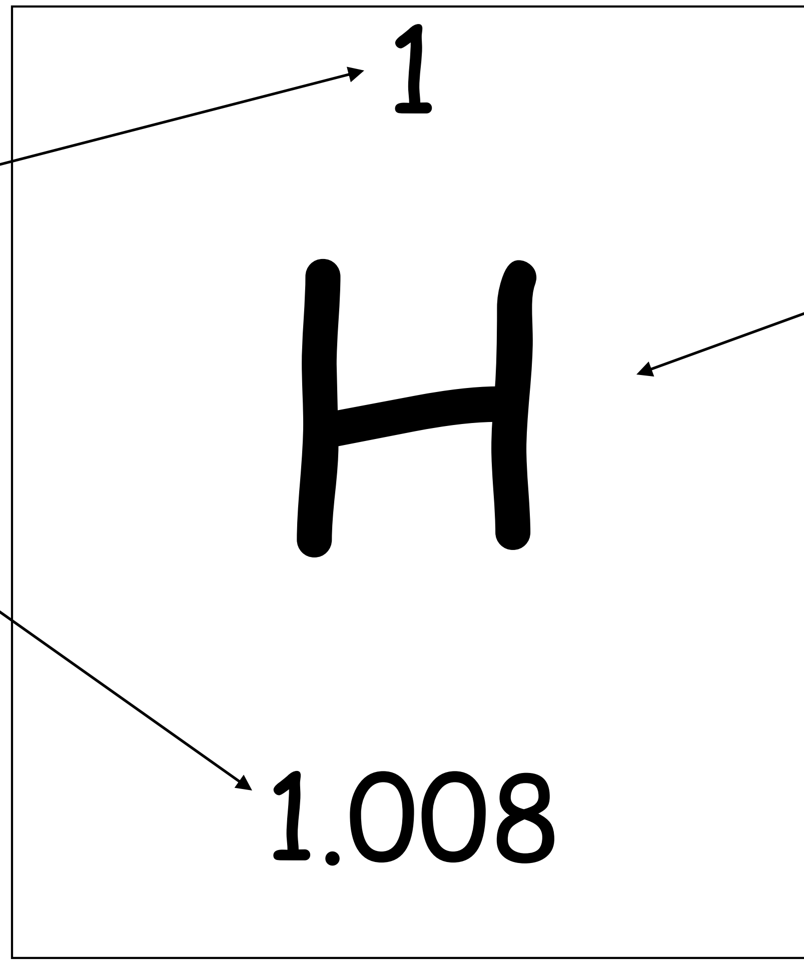
- Column (up and down)= Group or Family
- 18 columns on the Periodic Table
- Row (side to side)= Period
- 7 rows on the Periodic Table

Electron Configuration



What does the information in the box tell me?

Atomic Number = # of protons



Elemental Symbol

Atomic Mass = actual mass of the atom

*if you round, you get Atomic mass Number (# of protons plus neutrons)

General Observations about the Periodic Table

A. The group number equals the number of outer electrons (those with the highest value of *n*) (main-group elements only)

B. The period number is the *n* value of the highest energy level.

C. The *n* value squared (n^2) gives the total number of orbitals in that energy level; $2n^2$ gives the maximum number of electrons in the energy level.

Practice:

Ask these questions every time you have to write an electron configuration

- Lithium:
  1. find the element on the periodic table   atomic # = 3
  2. what is the period number?   2
  3. how many shells?   2
  4. what is the group number?   1
  5. how many valence electrons?   1
  6. what subshell(s) does Li have?   s
  7. what is the electron configuration? $1s^2\ 2s^1$

Practice:

Ask these questions every time you have to write an electron configuration

- Boron:
  1. find the element on the periodic table atomic # = 5
  2. what is the row #? 2
  3. how many shells? 2
  4. what is the group #? 3
  5. how many valence electrons? 3
  6. what subshell(s) does B have? S, p
  7. what is the electron configuration? $1s^2\ 2s^2\ 2p^1$

Types of Elements

1-Metals

On the left side of the periodic table

Properties:

1-Good conductors of electricity and heat

2-Shiny in appearance (metallic!)

2-Non metals:

Elements on the right side of the periodic table.

Their Properties are opposite to those of metals.

1-Usually poor conductors of heat and electricity

2-Not shiny, malleable, or ductile

3-Most are gases

3-**Metalloids**

1. They have the properties of both metals and non-metals.
2. Most common metalloid is silicon, which is the second most common element in the Earth's crust.

Metallic Behavior

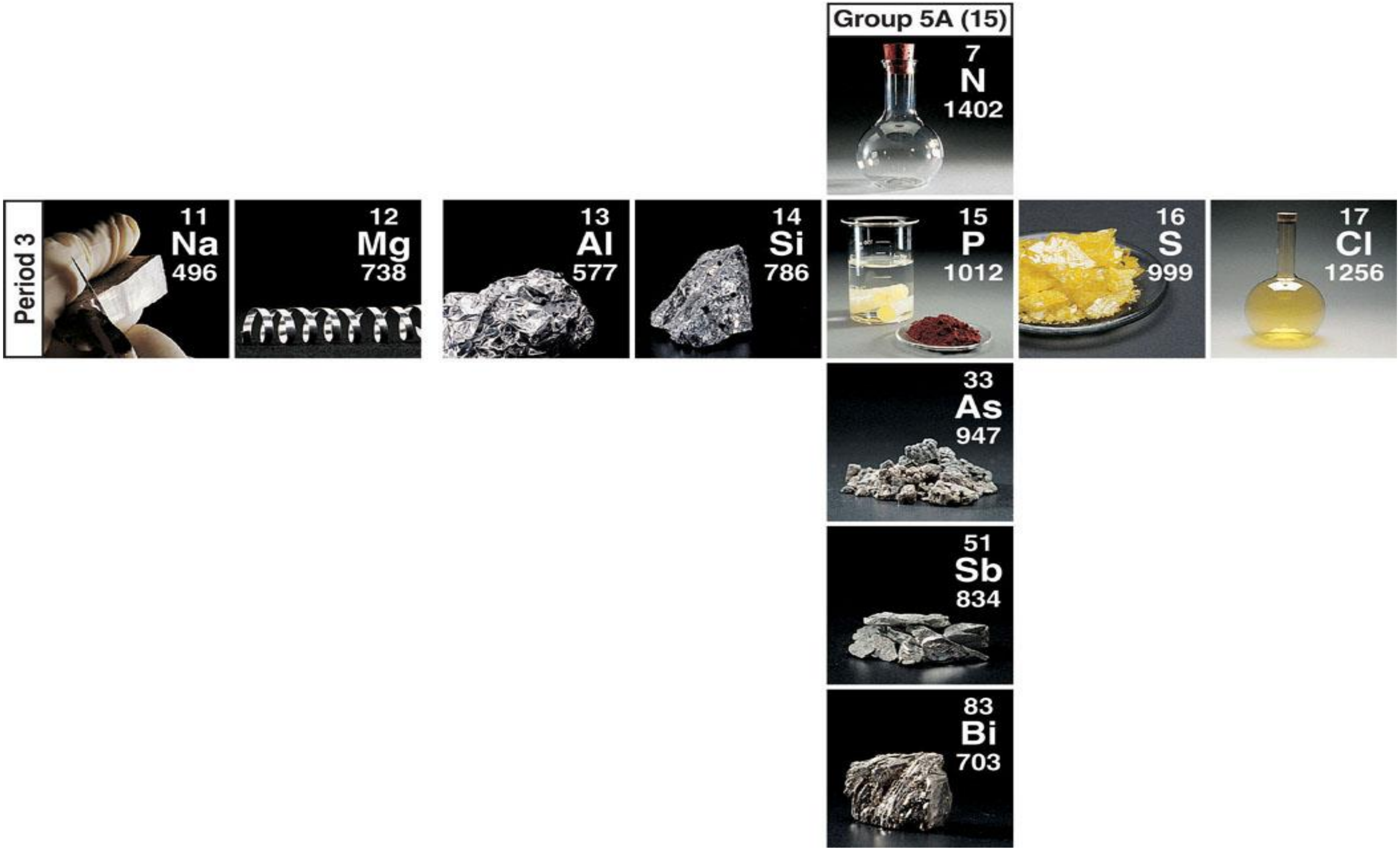
Metals: shiny solids; tend to lose electrons in reactions with non-metals (left and lower 3/4 of periodic table)

Non-metals: tend to gain electrons in reactions with metals;upper right-hand quarter of periodic table

Metalloids: have intermediate properties; located between the metals and non-metals in the periodic table

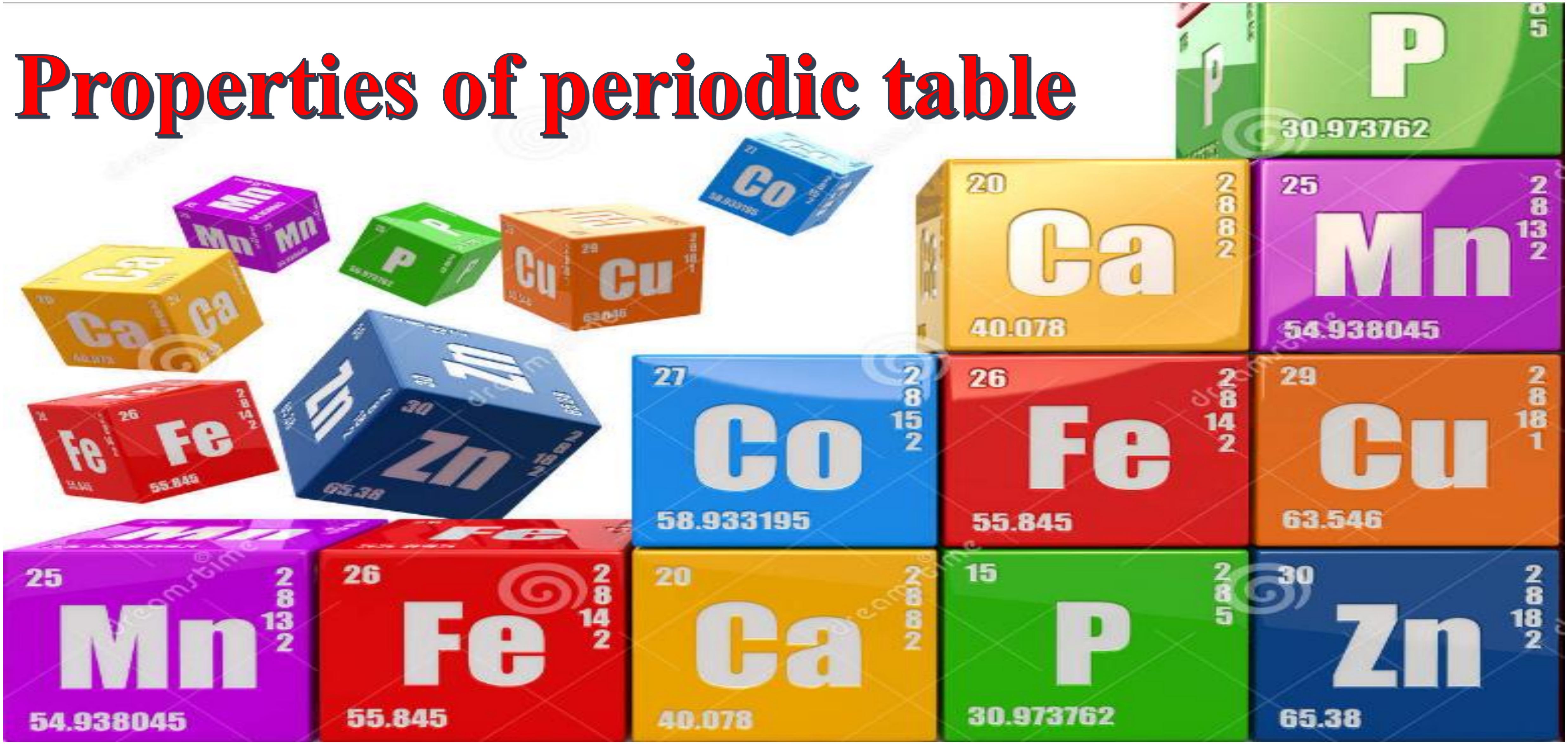
Metallic behavior decreases left to right and increases top to bottom in the periodic table

The change in metallic behavior in Group 5A(15) and Period 3



Third Lecture

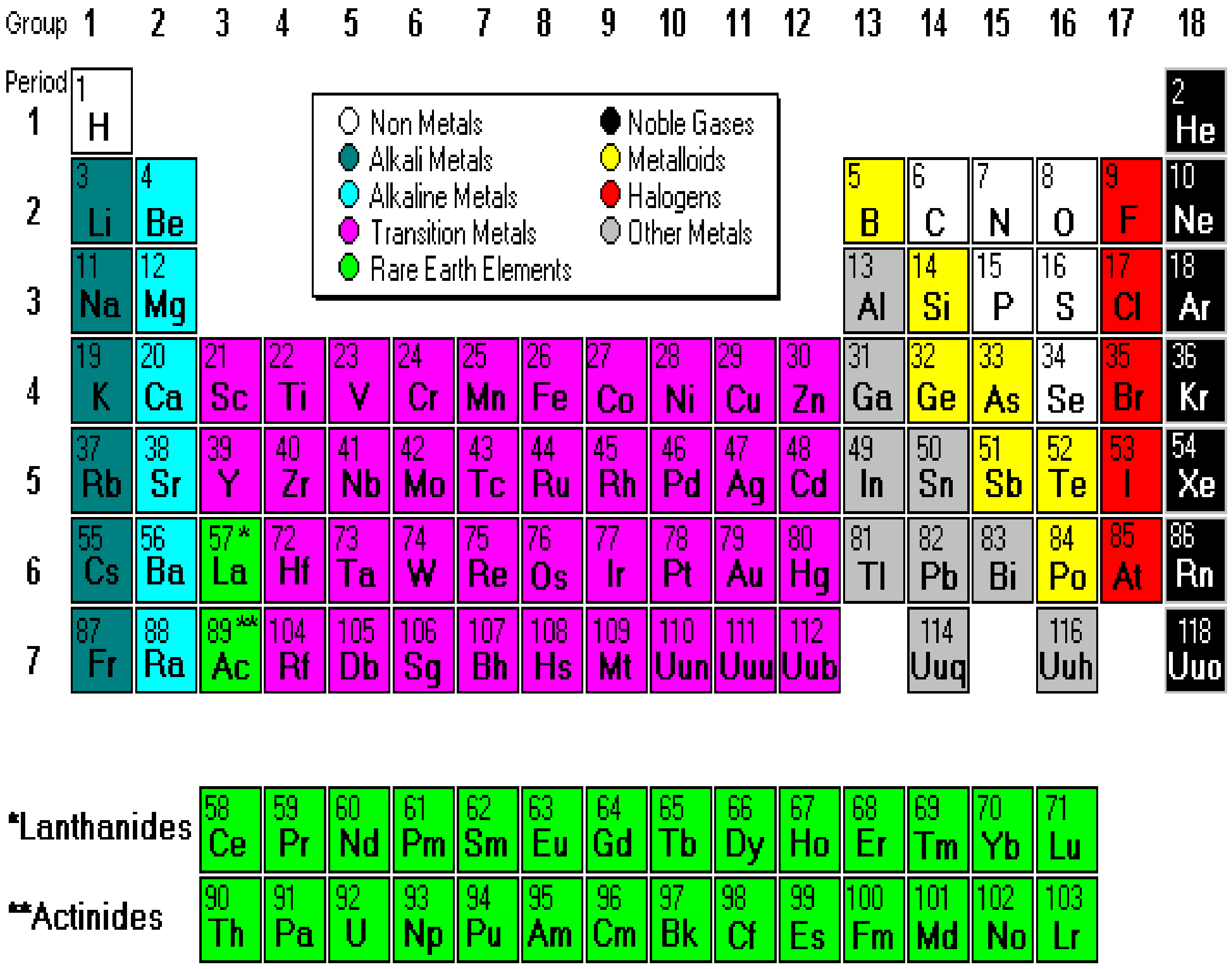
Properties of periodic table



Periodic Trends

- Trends we'll be looking at:

1. Atomic Radius and Ionic Radius
2. Ionization Energy
3. Electronegativity
4. The Electron Affinity(EA)
5. Metallic Character

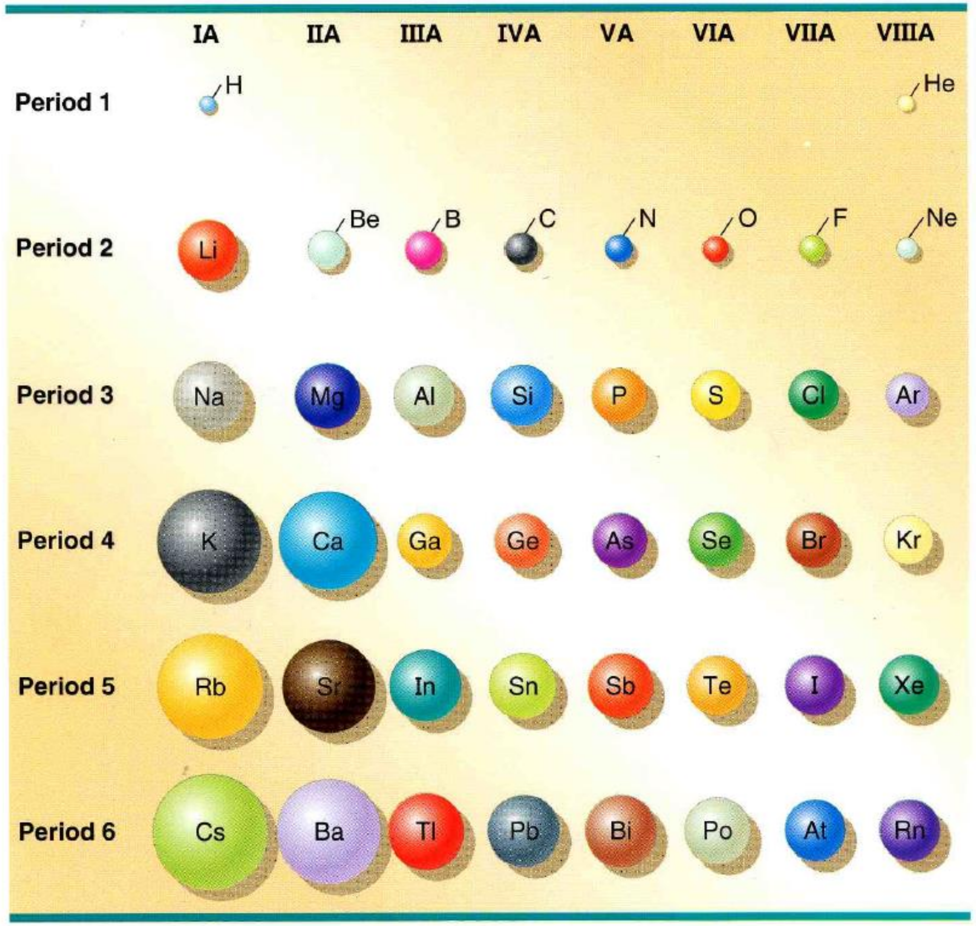


Periodic Groups

- Elements in the same column have similar chemical and physical properties.

- These similarities are observed because elements in a column have similar e^- configurations (same amount of electrons in outer shell).

Atomic Radius



- Atomic Radius – size of an atom

(distance from nucleus to the outer e^-).

Atomic Radius Trend

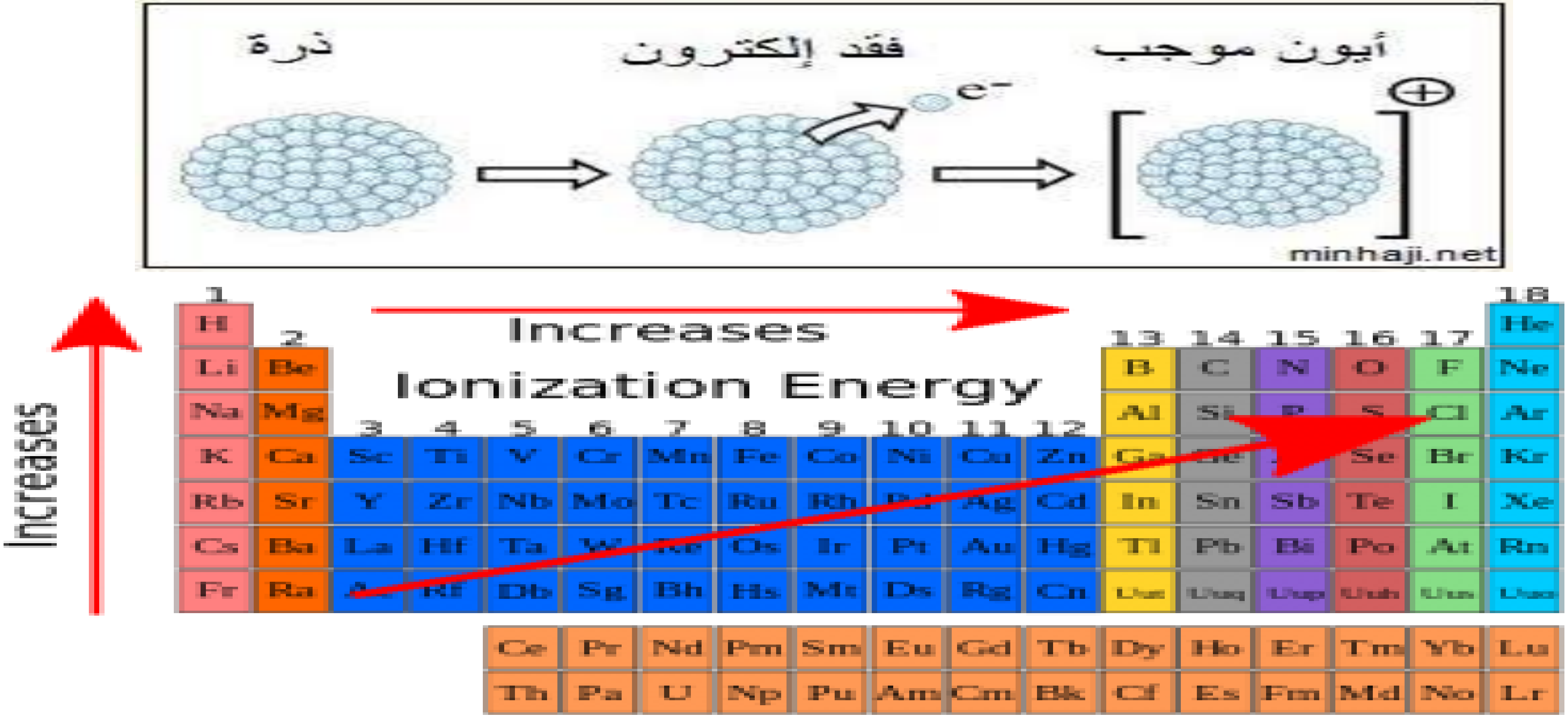
- Group Trend – As you go down a column, atomic radius increases.

As you go down, e^- are filled into orbitals (energy levels) that are farther away from the nucleus (attraction not as strong).

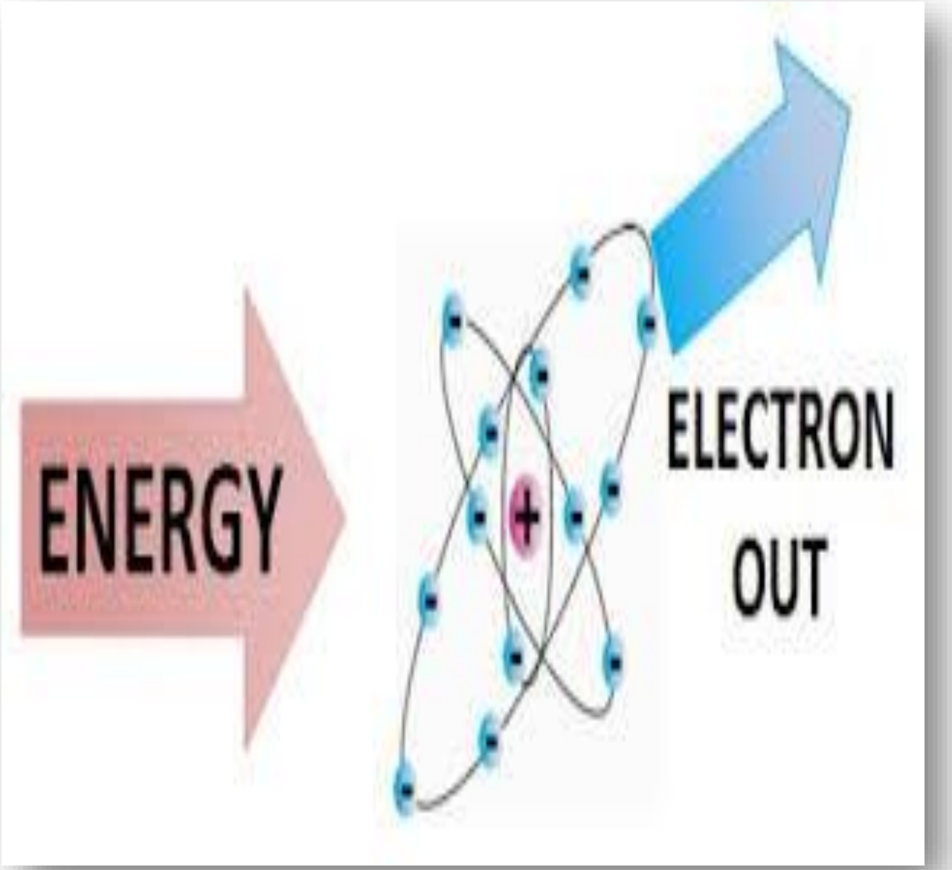
- Periodic Trend – As you go across a period (L to R), atomic radius decreases.

As you go L to R, e^- are put into the same energy level, but more p^+ and e^- total (more attraction = smaller size).

2-Ionization energy: the amount of **energy** required to remove an electron from an isolated gas atom or molecule.



$$X(g) + energy \longrightarrow X^{+}(g) + e^{-}$$



$$Na^{0} + E \longrightarrow Na^{+1} + e^{-}$$

Ionization Energy

The amount of energy required for the complete removal of 1 mol of electrons from 1 mol of gaseous atoms or ions; an energy-requiring process; value is positive in sign

IE_1 = first ionization energy : removes an outermost electron from the gaseous <u>atom</u>: atom(*g*) ⟶ $ion^+(g) + e^-$ $\Delta E = IE_1 > 0$

IE_2 = second ionization energy : removes a second electron from the gaseous <u>ion</u>: $ion^+(g)$ ⟶ $ion^{+2}(g) + e^-$ $\Delta E = IE_2 > IE_1$

Atoms with a low IE_1 tend to form cations during reactions, whereas those with a high IE_1 (except noble gases) often form anions.

Ionization Energies: Correlations with Atomic Size

1. As size decreases, it take *more* energy to remove an electron.

2. Ionization energy generally *decreases* down a group.

3. Ionization generally *increases* across a period.

Periodicity of first ionization energy (IE_1)

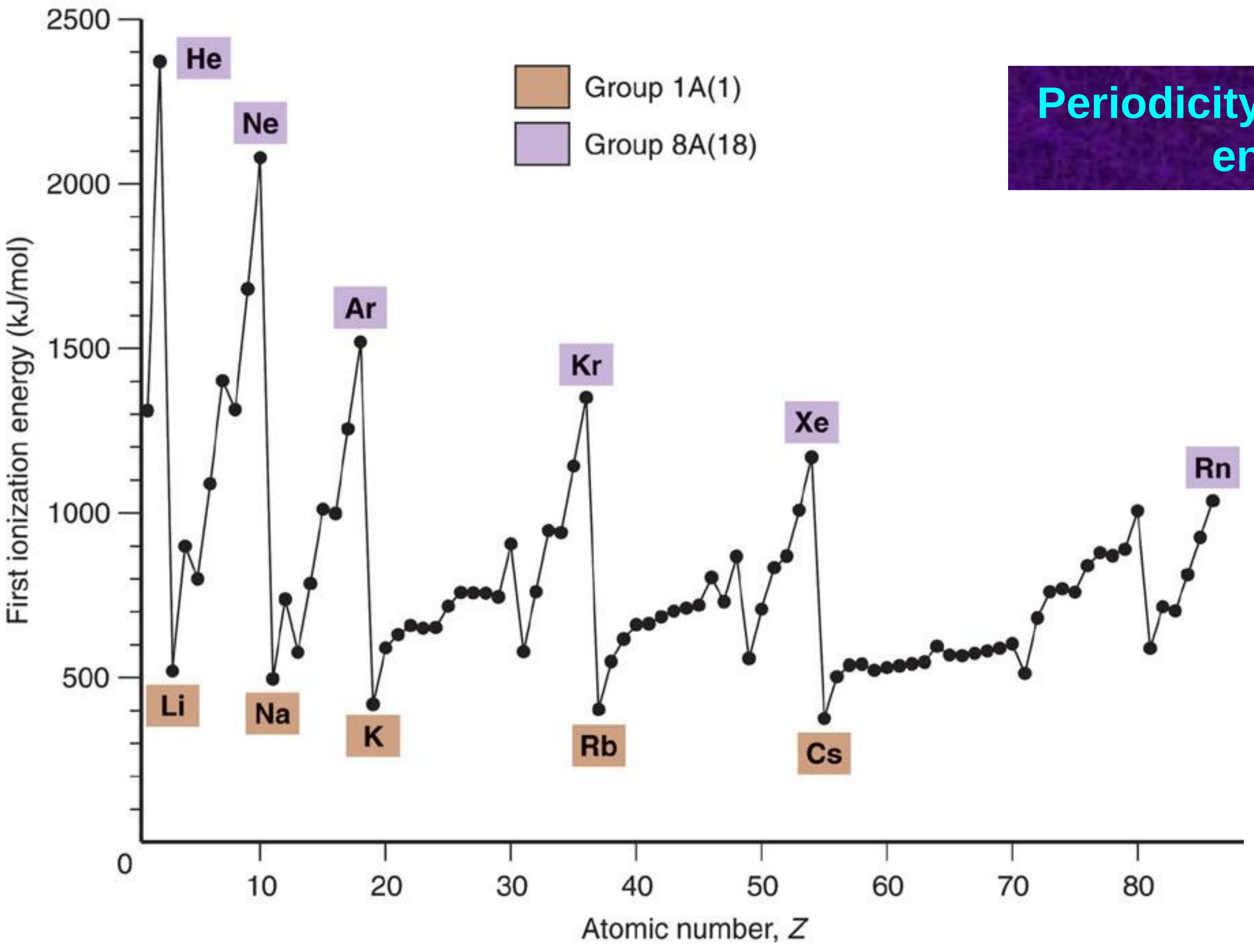


Figure 8.17

Lowest values for alkali metals; highest values for noble gases

First ionization energies of the main-group elements

Increase within a period and decrease within a group

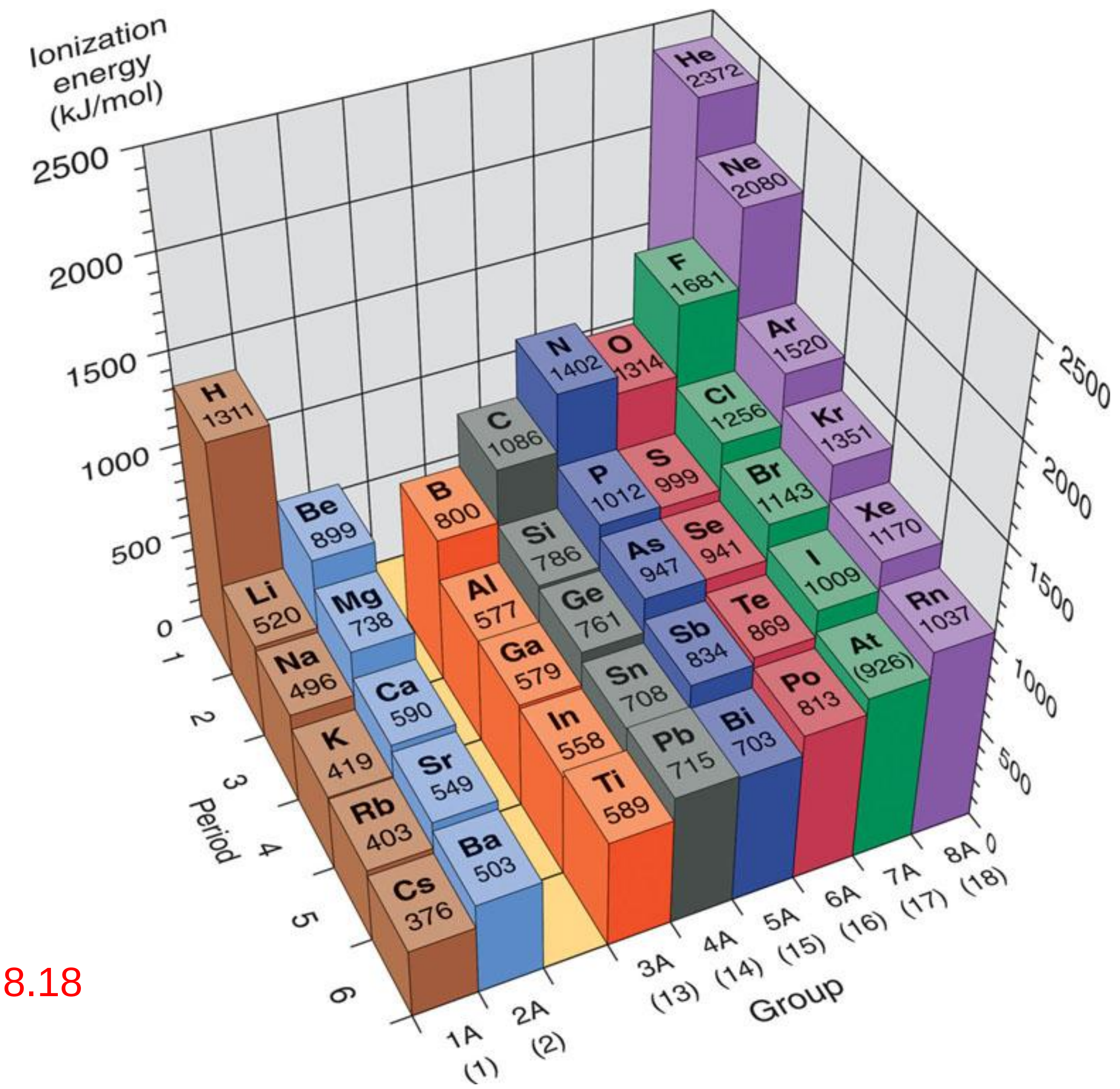
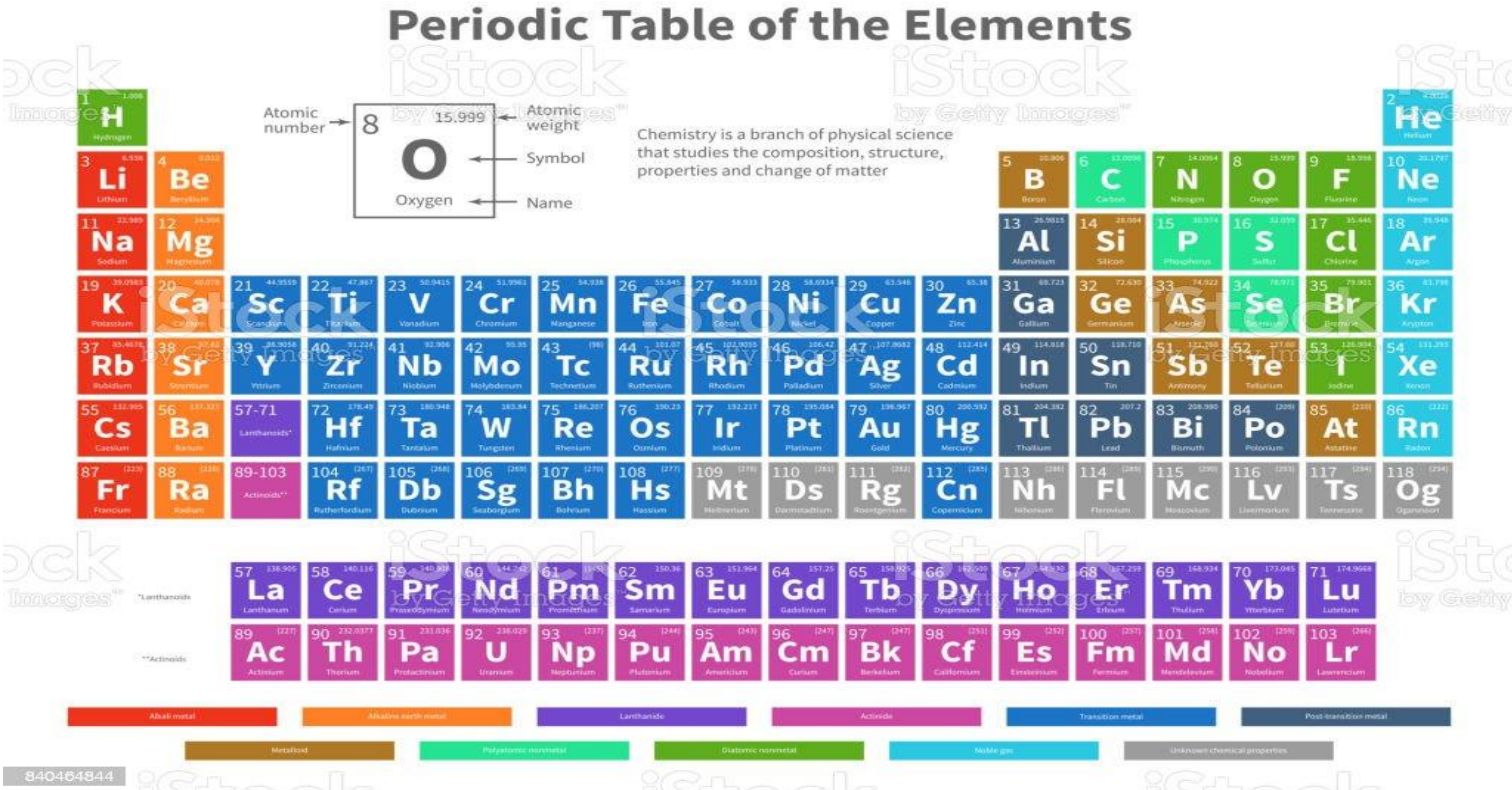


Figure 8.18



Periodic Table of the Elements
Atomic number
8
15.999
O
Oxygen
Atomic weight
Symbol
Name
Chemistry is a branch of physical science that studies the composition, structure, properties and change of matter
1 H
2 He
3 Li
4 Be
5 B
6 C
7 N
8 O
9 F
10 Ne
11 Na
12 Mg
13 Al
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
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
57-71
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
89-103
104 Rf
105 Db
106 Sg
107 Bh
108 Hs
109 Mt
110 Ds
111 Rg
112 Cn
113 Nh
114 Fl
115 Mc
116 Lv
117 Ts
118 Og
57 La
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
89 Ac
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
840464844

SAMPLE PROBLEM 8.4 Ranking Elements by First Ionization Energy

PROBLEM: Using the periodic table, rank the elements in each of the following sets in order of decreasing IE_1:

(a) Kr, He, Ar **(b)** Sb, Te, Sn **(c)** K, Ca, Rb **(d)** I, Xe, Cs

PLAN: IE decreases down in a group; IE increases across a period.

SOLUTION:

(a) He > Ar > Kr — **Group 8A elements-** IE decreases down a group.

(b) Te > Sb > Sn — **Period 5 elements -** IE increases across a period.

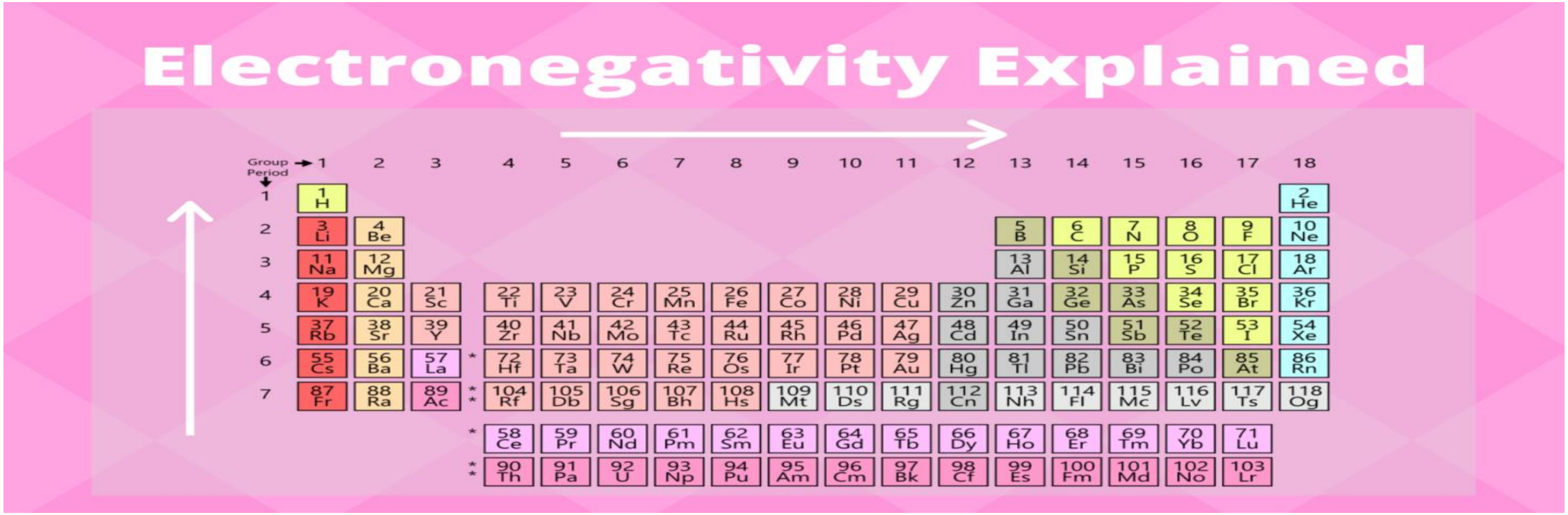
(c) Ca > K > Rb — **Ca is to the right of K(same period);** Rb is below K.(same group)

(d) Xe > I > Cs — **Period 5 elements -** **I is to the left of Xe;** Cs is further to the left and down one period.

3- Electronegativity:

It is a function of an atom's ability to attract an electron in chemical bonding.

the Pauling scale. Fluorine is assigned a value of 4.0, and values that are the least electronegative at 0.7 range down to cesium and francium



4- *The **Electron Affinity(EA)***

amount of energy released when an electron is added to a neutral atom to form an anion

$$Cl^0 + e \longrightarrow Cl^-$$

Electronegativity Trend (really electron affinity)

- Group Trend – As you go down a column, electron affinity decreases.

As you go down, atomic size is increasing, so less attraction of electrons to the nucleus.

Periodic Trend – As you go across a period (L to R), electron affinity increases.

As you go L to R, atomic size is decreasing, so the electrons are more attracted to the nucleus.

Electron affinities of the main-group elements

Negative values = energy is released when the ion forms

Positive values = energy is absorbed to form the anion

In general, electron affinity becomes more exothermic as you go from left to right across a row.

1A (1)	2A (2)	3A (13)	4A (14)	5A (15)	6A (16)	7A (17)	8A (18)
H −72.8							He (0.0)
Li −59.6	Be (+18)	B −26.7	C −122	N +7	O −141	F −328	Ne (+29)
Na −52.9	Mg (+21)	Al −42.5	Si −134	P −72.0	S −200	Cl −349	Ar (+35)
K −48.4	Ca (+186)	Ga −28.9	Ge −119	As −78.2	Se −195	Br −325	Kr (+39)
Rb −46.9	Sr (+146)	In −28.9	Sn −107	Sb −103	Te −190	I −295	Xe (+41)
Cs −45.5	Ba (+46)	Tl −19.3	Pb −35.1	Bi −91.3	Po −183	At −270	Rn (+41)

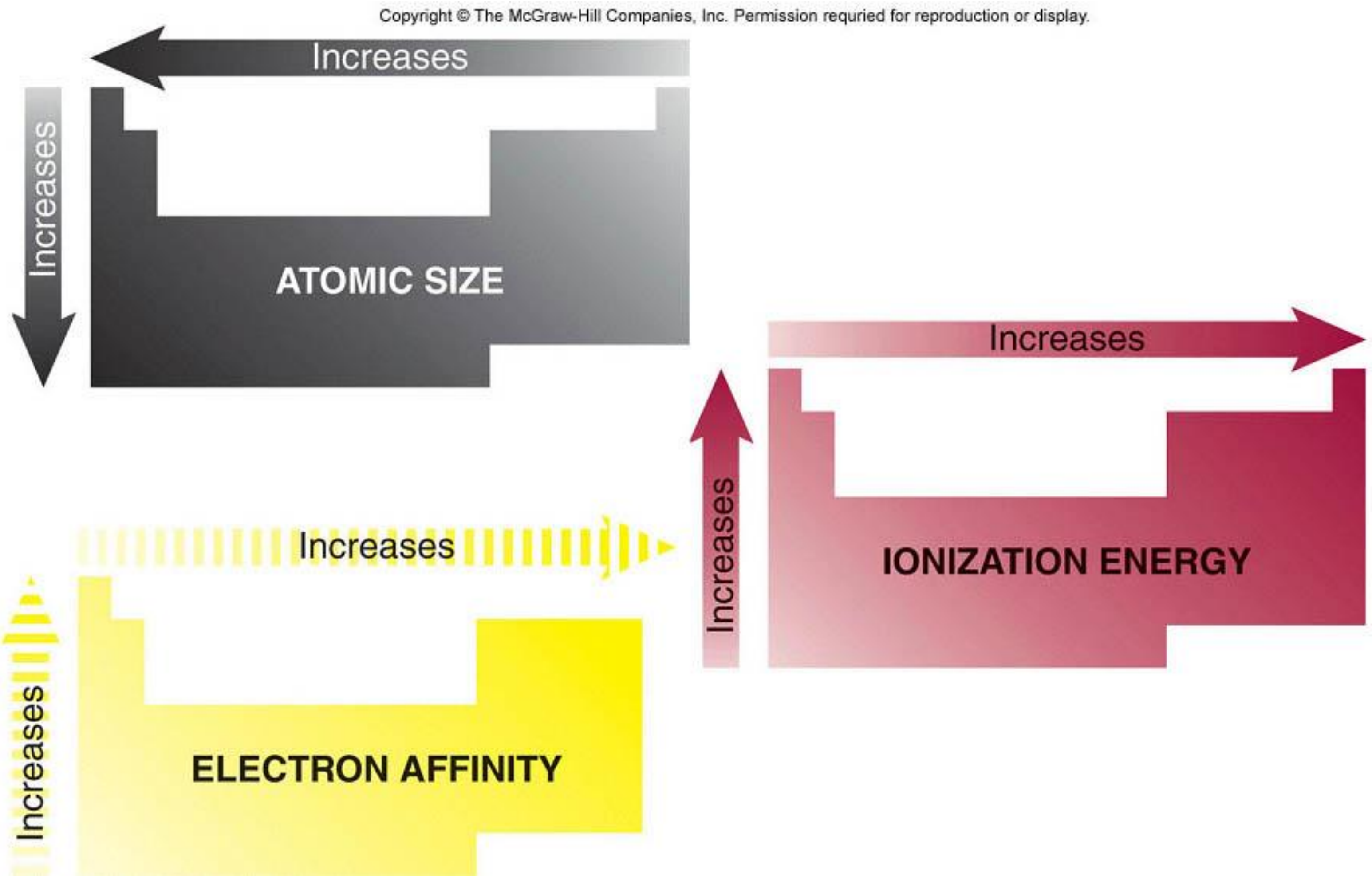
General Trends Involving IEs and EAs

Reactive non-metals: Groups 6A and 7A; in their ionic compounds they form negative ions (have high IEs and very (-) EAs)

Reactive metals: Group 1A; in their ionic compounds, they form positive ions (have low IEs and slightly (-) EAs)

Noble gases: Group 8A; they do not lose or gain electrons (have very high IEs and slightly (+) EAs)

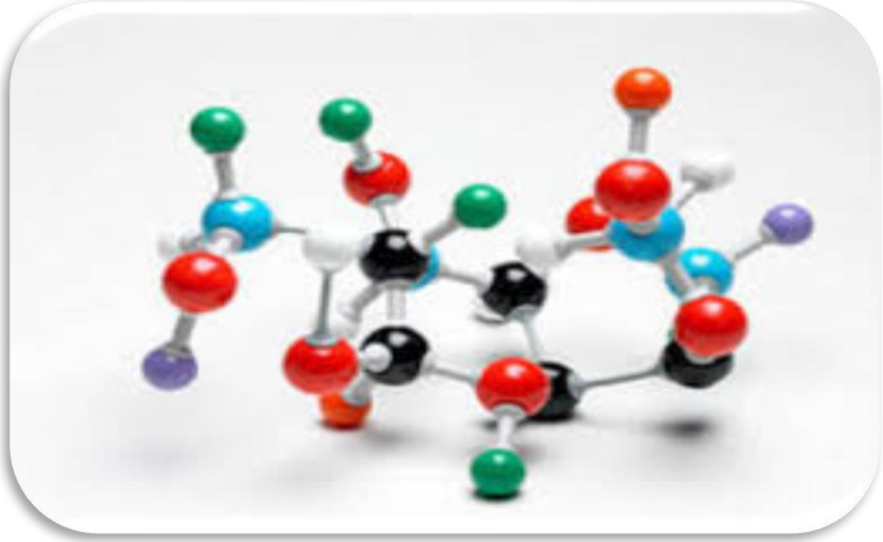
Trends in three atomic properties



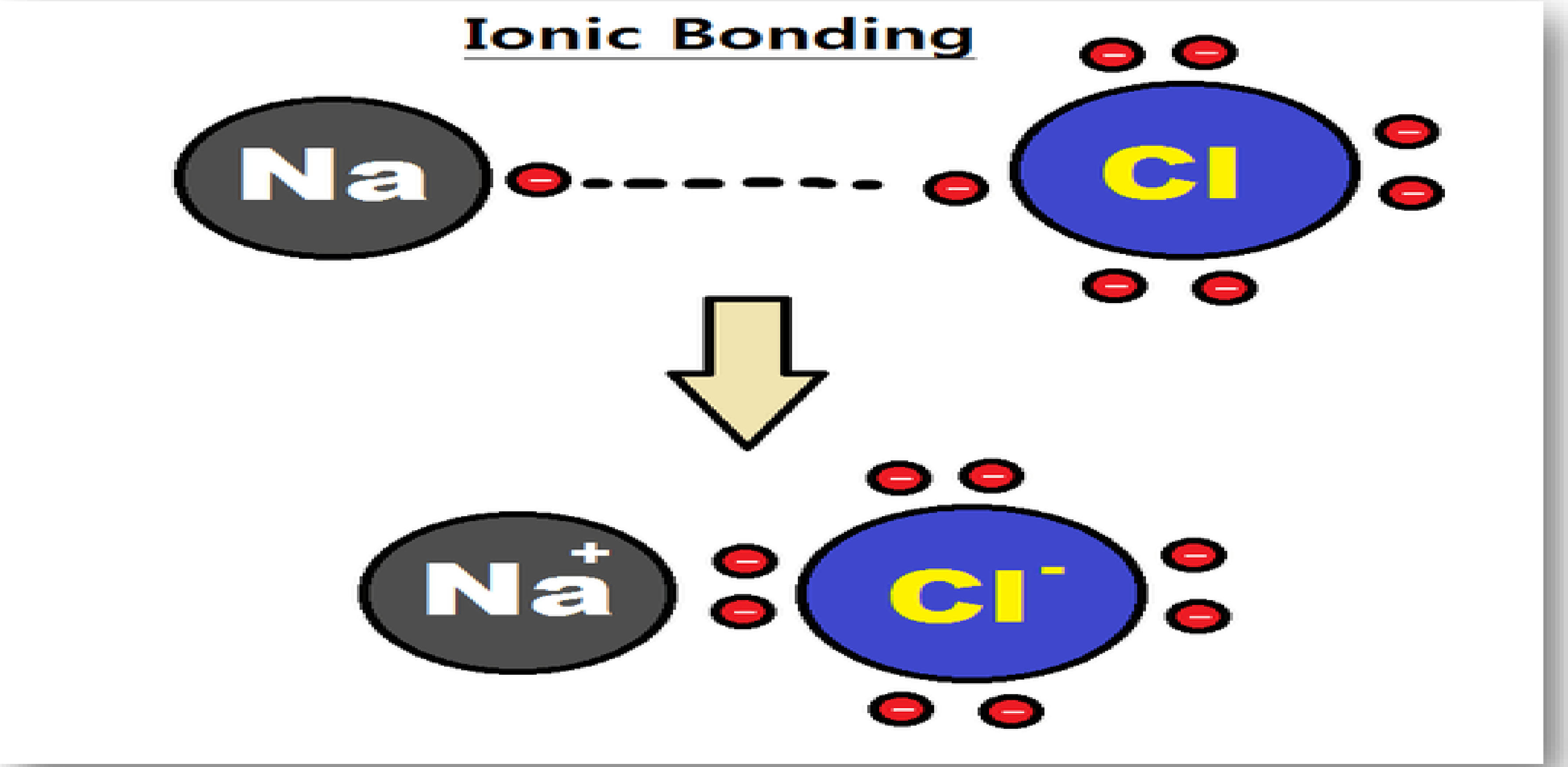
Type of chemical bonds:

***Chemical** bonds: are forces hold atoms together to make compounds or molecules

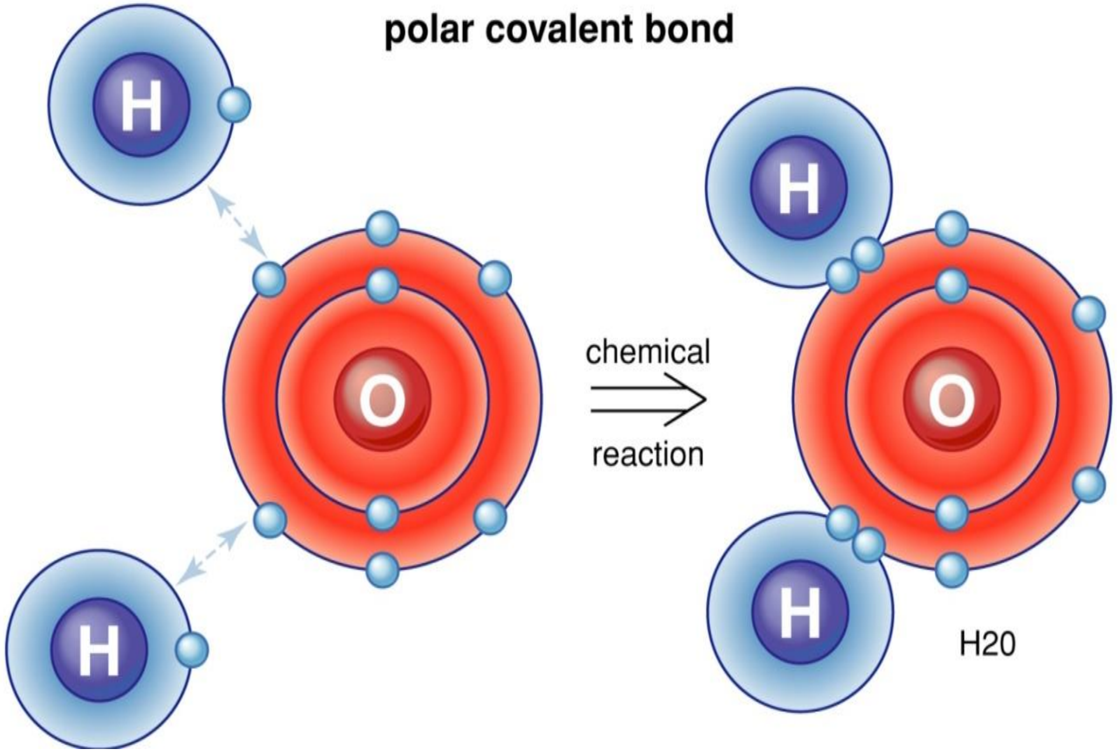
***Chemical** bonds include covalent, polar covalent, and ionic bonds

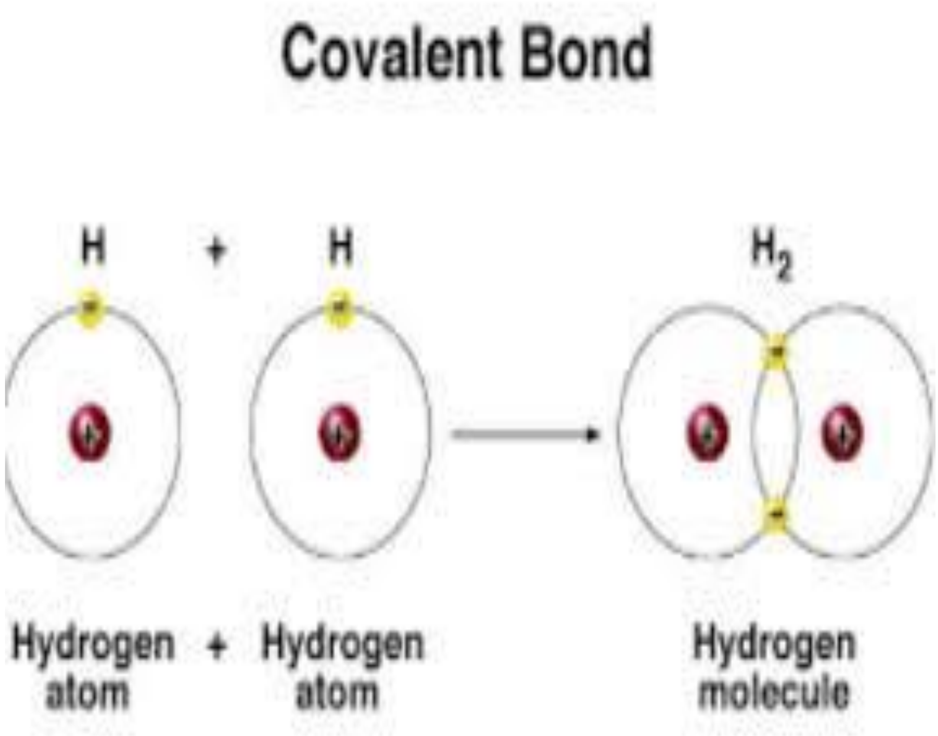


1- Ionic bond: is the complete transfer of valence electron(s) between atoms



2-covalent bond is a chemical **bond** that involves the sharing of electron pairs between atoms.

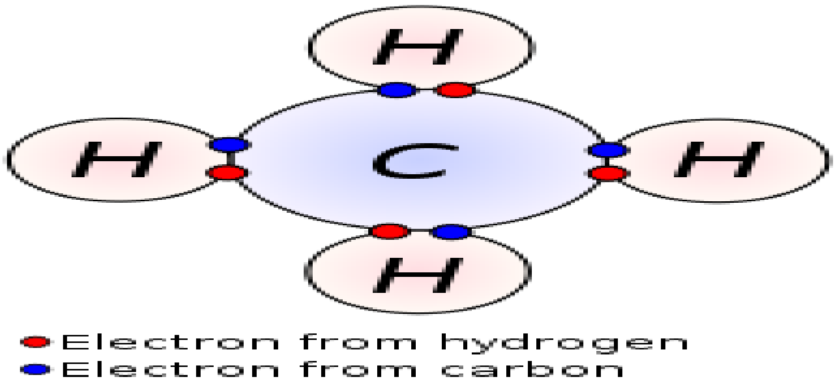




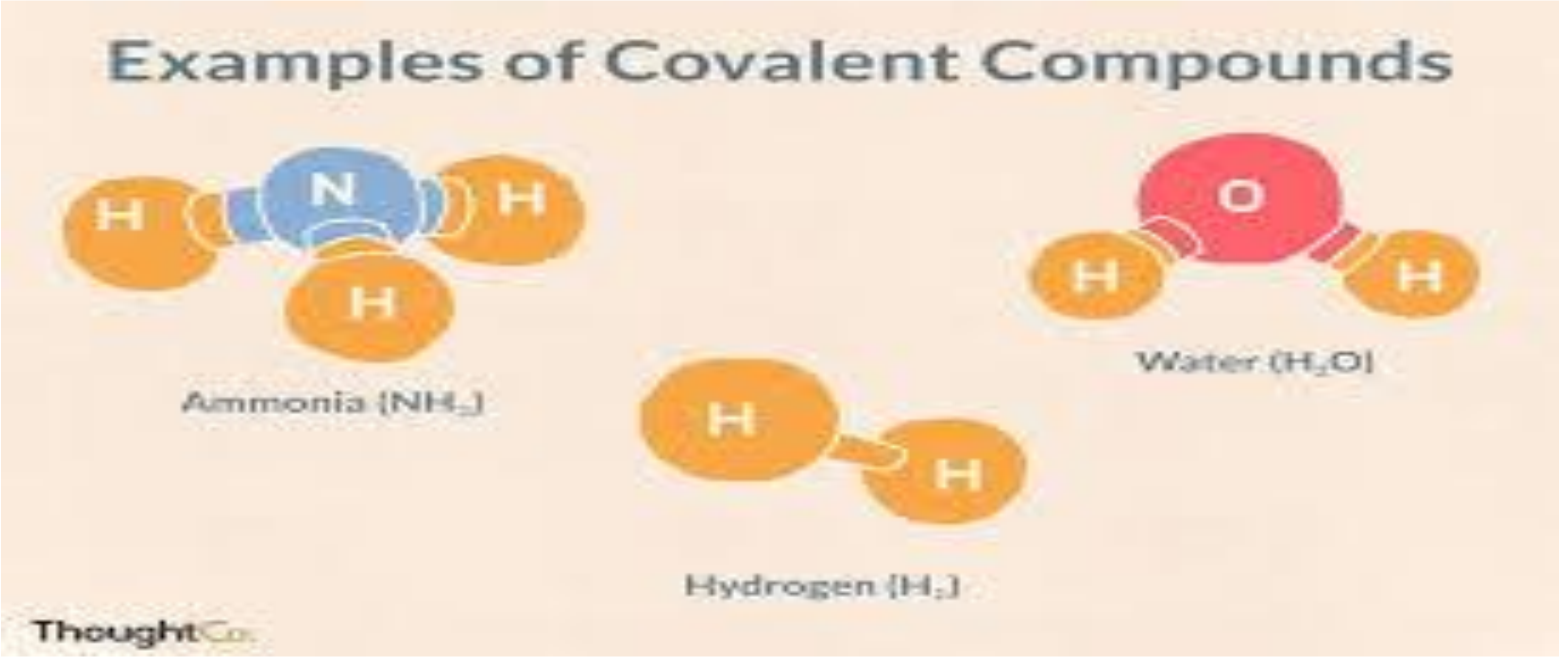
3- polar bond is a covalent **bond** between two atoms where the electrons forming the **bond** are unequally distributed. This causes the molecule to have a slight electrical dipole moment where one end is slightly positive and the other is slightly negative.

A non-polar covalent bond is a type of chemical bond that is formed when electrons are shared equally between two atoms.

CH4

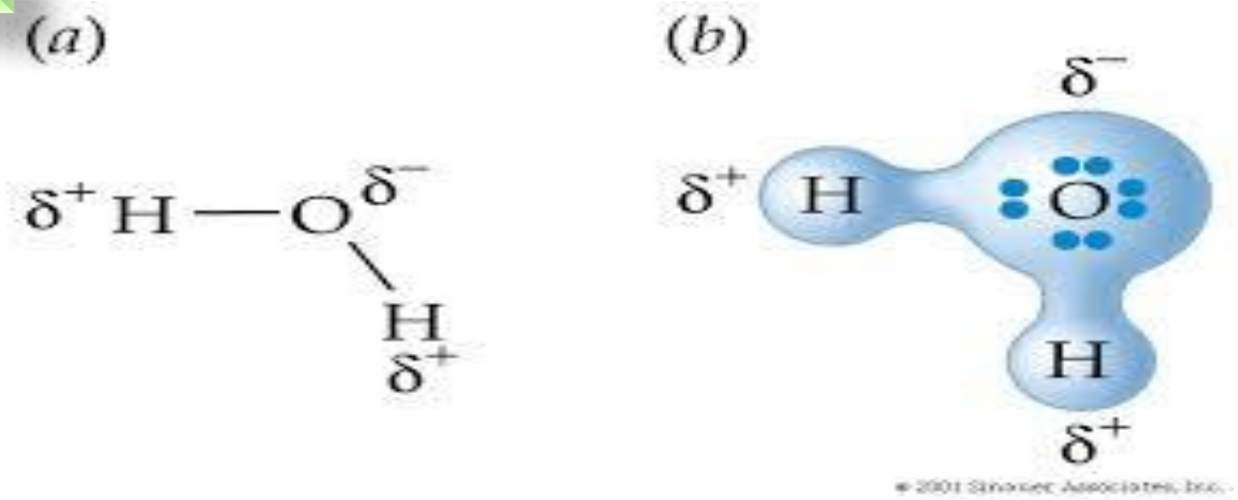


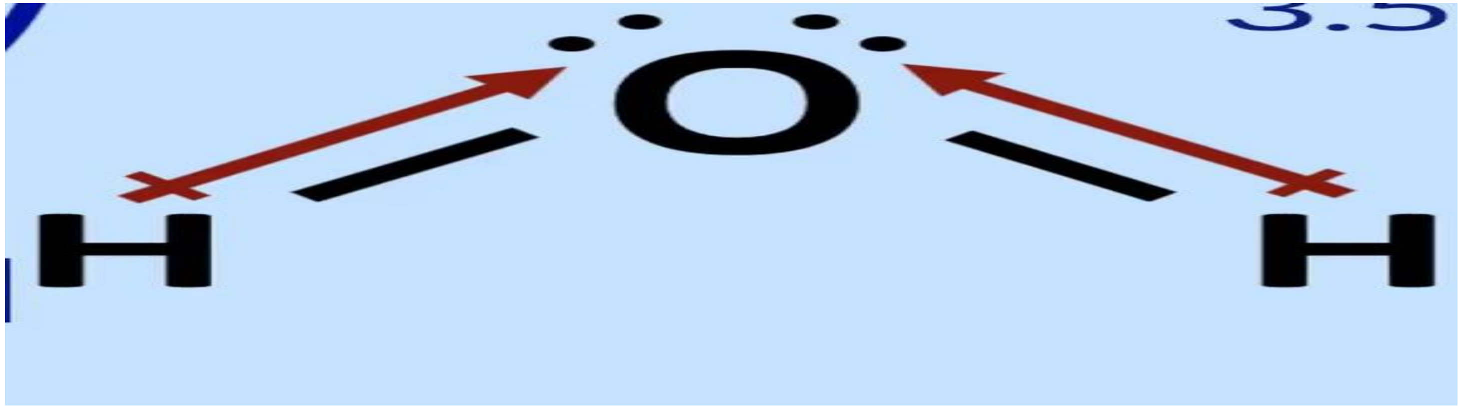
Another examples:



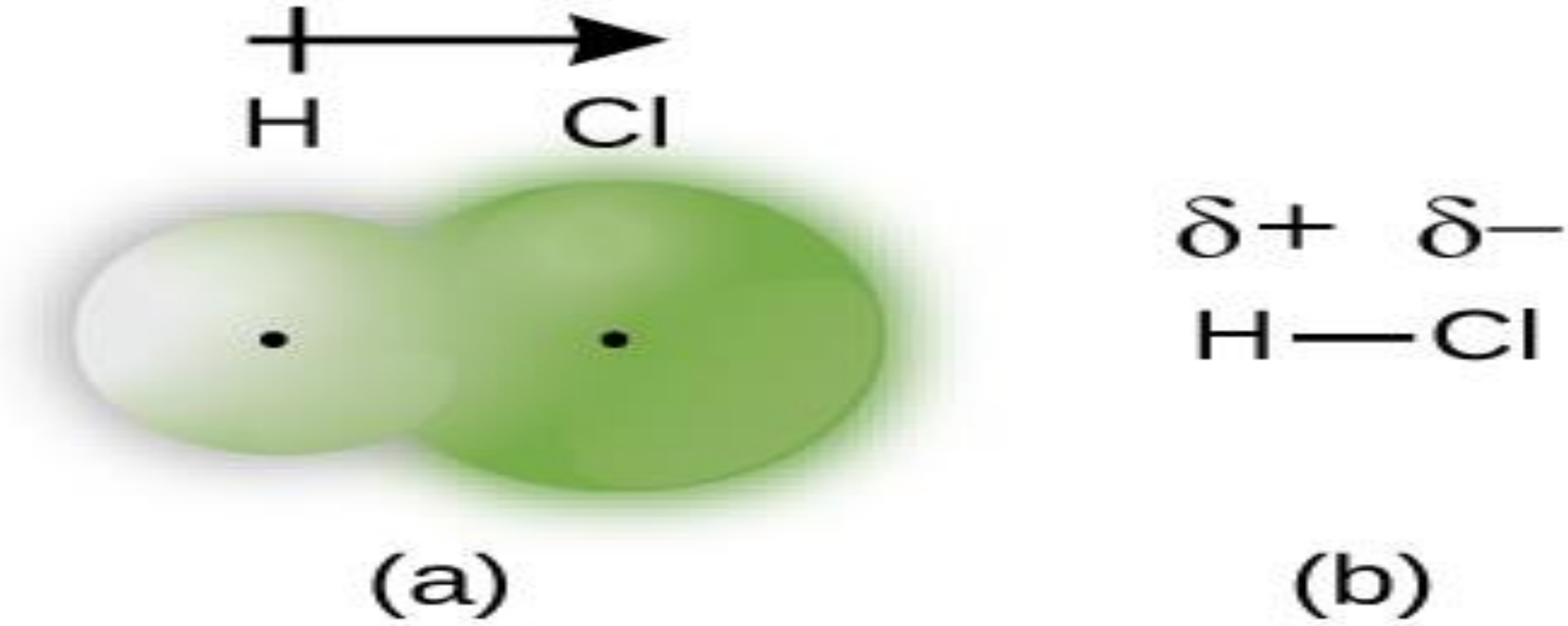
Example of polar bond:

1) **H_2O**

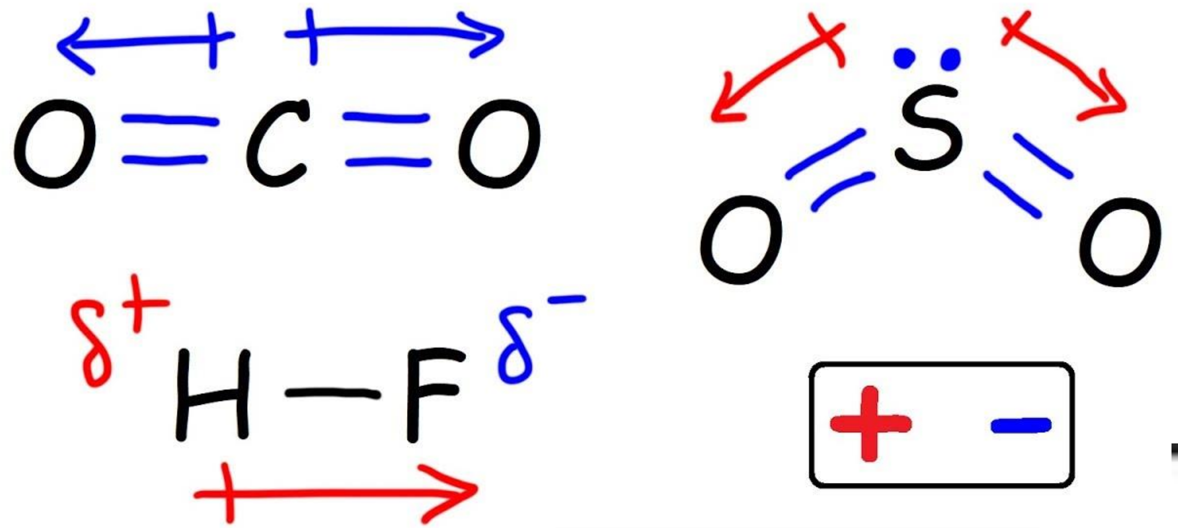


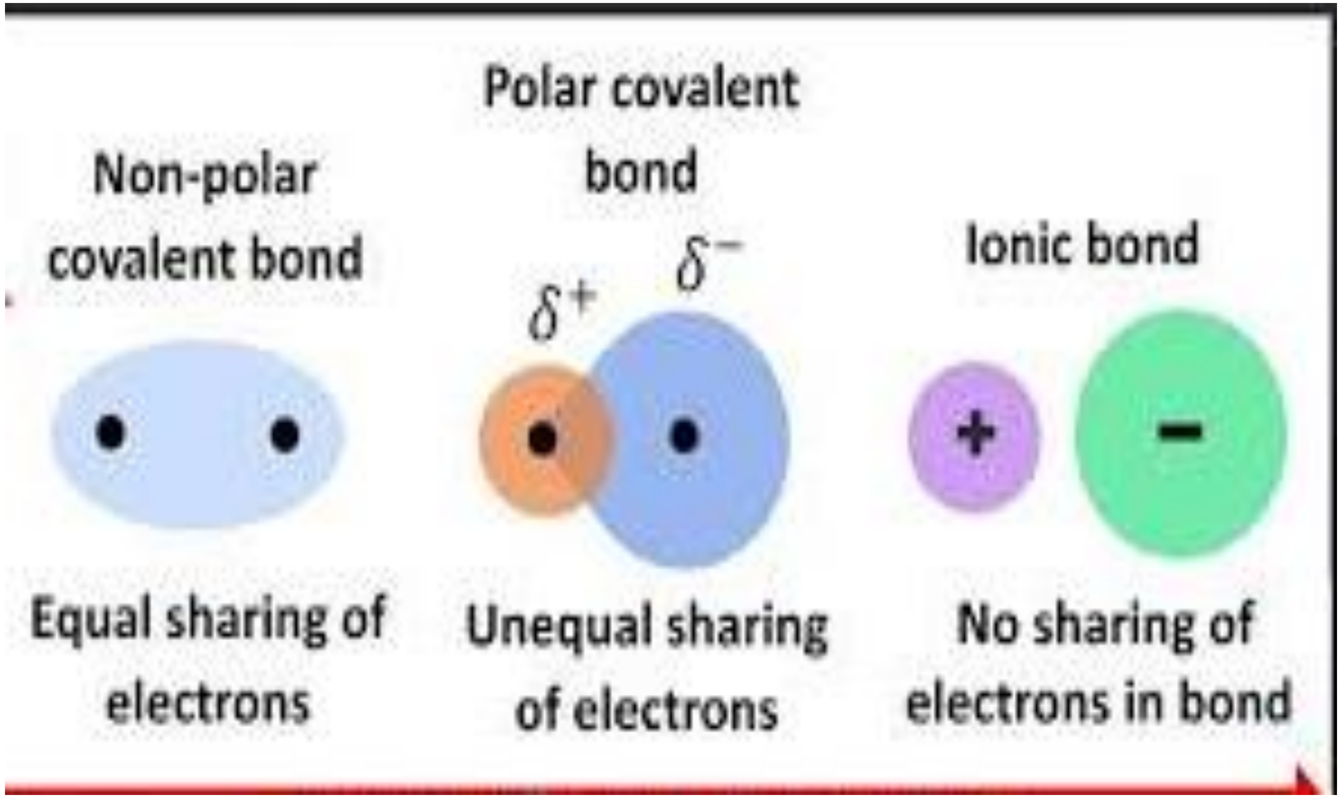


2) HCl



Polar & Nonpolar Molecules





The molecules have polar covalent bond differ in their tendency to attract electron , and that is mean differ in electro negativity .

The most electro negativity of elements are those located in the upper right hand corner of the periodic table .

F > O > Cl . N > Br > C , H

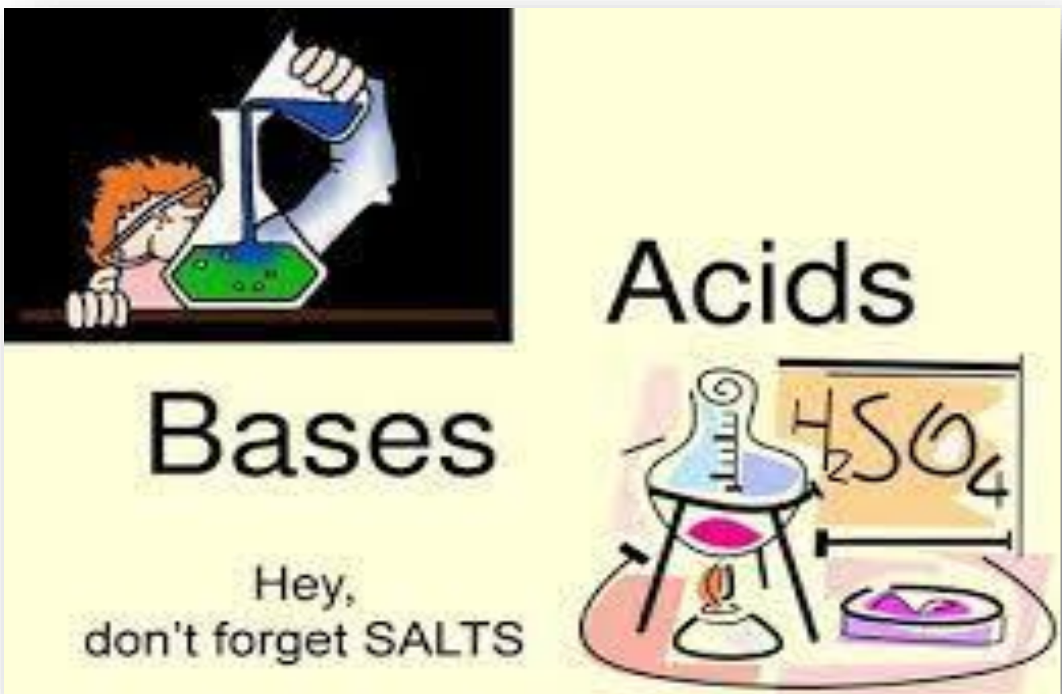
Electro negativity for some elements

The polarity of bond can lead to polarity of molecule and thus effect in melting point and solubility .

Lec No./ 4

1)Acid and base

2)Analytical chemistry



Acids & Bases

They are everywhere..

In your food

In your house

EVEN IN YOU!!!!!

What is an acid?

- An acid is a solution that has an excess of H^+ ions. It comes from the Latin word acidus that means "sharp" or "sour".
- The more H^+ions,the more acidic the solution.

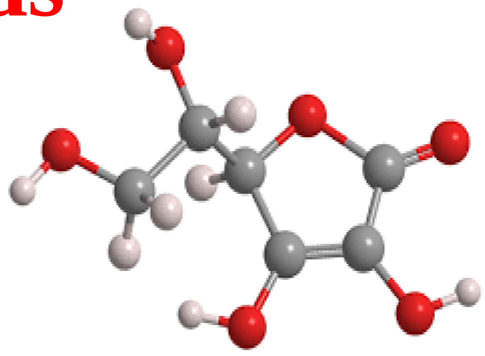
- **Acids are Proton (H^+ ion) Donors**

  Strong acids are assumed to be 100% ionized in solution (good H^+ donors)

  HCl , H_2SO_4 , HNO_3

- Weak acids are usually less than 5% ionized in solution (poor H^+ donors)

  H_3PO_4 $HC_2H_3O_2$ Organic acids

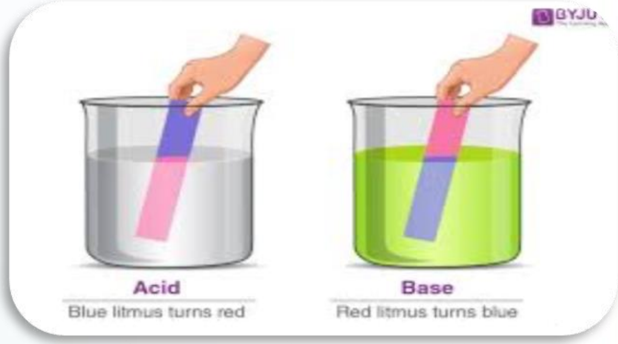


ACIDS AND BASES

Properties of an Acids

- Acids are proton (hydrogen ion , H+) donors
- Acids have a pH lower than 7
- Acids taste sour
- Acids effect indicators

- Blue litmus turns red
- Methyl orange turns red



- Acids react with active metals , producing H_2
- Acids react with carbonates
- Acids neutralize bases

Properties of an Acid

- **Tastes Sour**
- **Conduct Electricity**
- **Corrosive, which means they break down certain substances. Many acids can corrode fabric, skin,and paper**
- **Some acids react strongly with metals**
- **Turns blue litmus paper to red**

Picture from BBC Revision Bites
http://www.bbc.co.uk/schools/ks3bitesize/science/chemistry/acids_bases_1.shtml

Acids React with Active Metals

Acids react with active metals to form salts and hydrogen gas

$$Mg + 2HCl \rightarrow MgCl_2 + H_2\,(g)$$

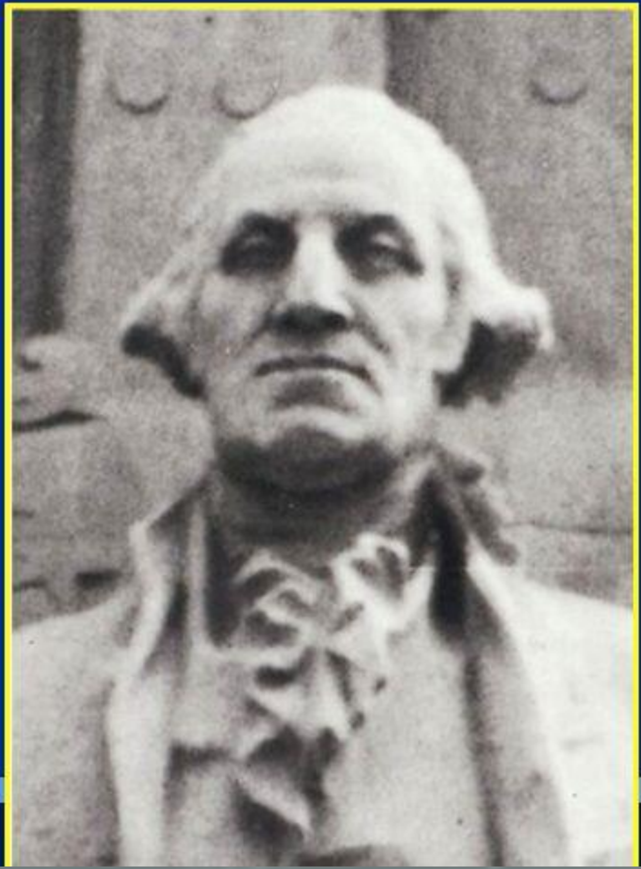
$$Zn + 2HCl \rightarrow ZnCl_2 + H_2\,(g)$$

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2\,(g)$$

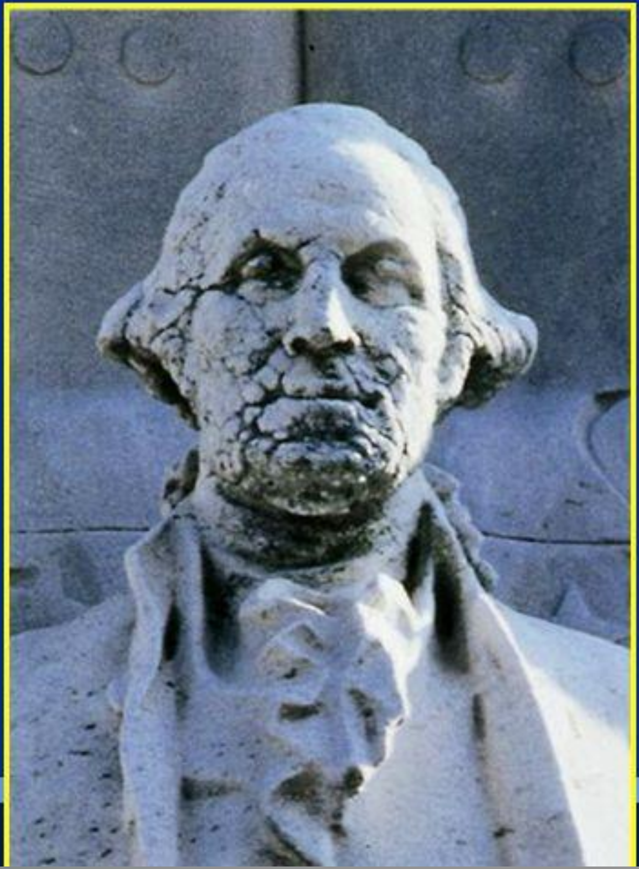
Effects of Acid Rain on Marble

(marble is calcium carbonate)

George Washington: BEFORE acid rain



George Washington: AFTER acid rain



Acids Neutralize Bases

Neutralization reactions ALWAYS produce a salt and water

$$HCl + NaOH \rightarrow NaCl + H_2O$$

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

$$2HNO_3 + Mg(OH)_2 \rightarrow Mg(NO_3)_2 + 2H_2O$$

Uses of Acids

Acids

- Acetic Acid = Vinegar
- Citric Acid = lemons, limes, & oranges. It is in many sour candies such as lemonhead & sour patch.
- Ascorbic acid = Vitamin C which your body needs to function.
- Sulfuric acid is used in the production of fertilizers,paints, and plastics.
- Car batteries

What is a base?

- **A base is a solution that has an excess of OH- ions.**
- **Another word for base is alkali.**
- **Bases are substances that can accept hydrogen ions**

Bases are Proton (H^+ ion) Acceptors

- Sodium hydroxide (lye) . NaOH
- Potassium hydroxide . KOH
- Magnesium hydroxide , $Mg(OH)_2$
- Calcium hydroxide (lime) , $Ca(OH)_2$

OH – (hydroxide) in base combines with H+ in acids to form water . $H^+ + OH^- \rightarrow H_2O$

Properties of Bases

– Bases are proton (hydrogen ion , H+) acceptors -

Bases have a pH greater than 7 .

- Bases taste bitter .

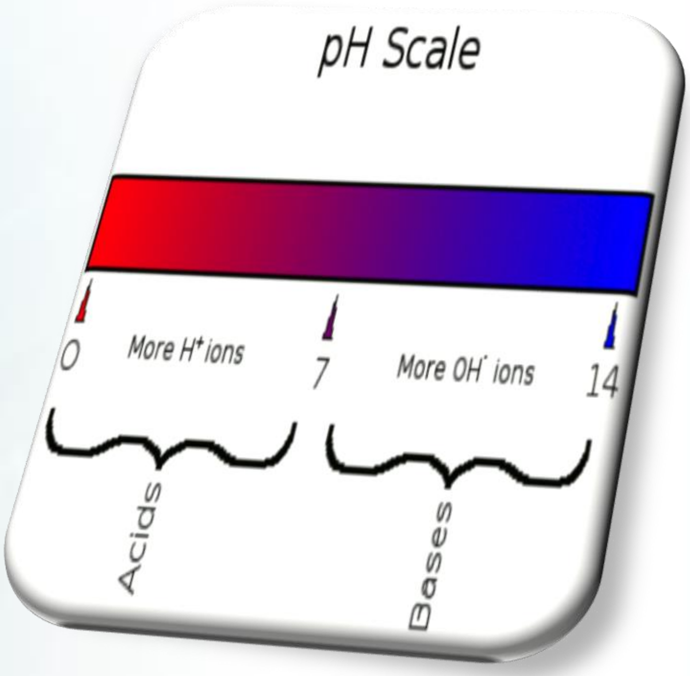
- Bases effect indicators

- Red litmus turns blue .

- Phenolphthalein turns purple .

• Solution of bases feel slippery .

• Bases neutralize acids .



Properties of a Base

- Feel Slippery
- Taste Bitter
- Corrosive
- Can conduct electricity. (Think alkaline batteries.)
- Do not react with metals.
- Turns red litmus paper blue.

Uses of Bases

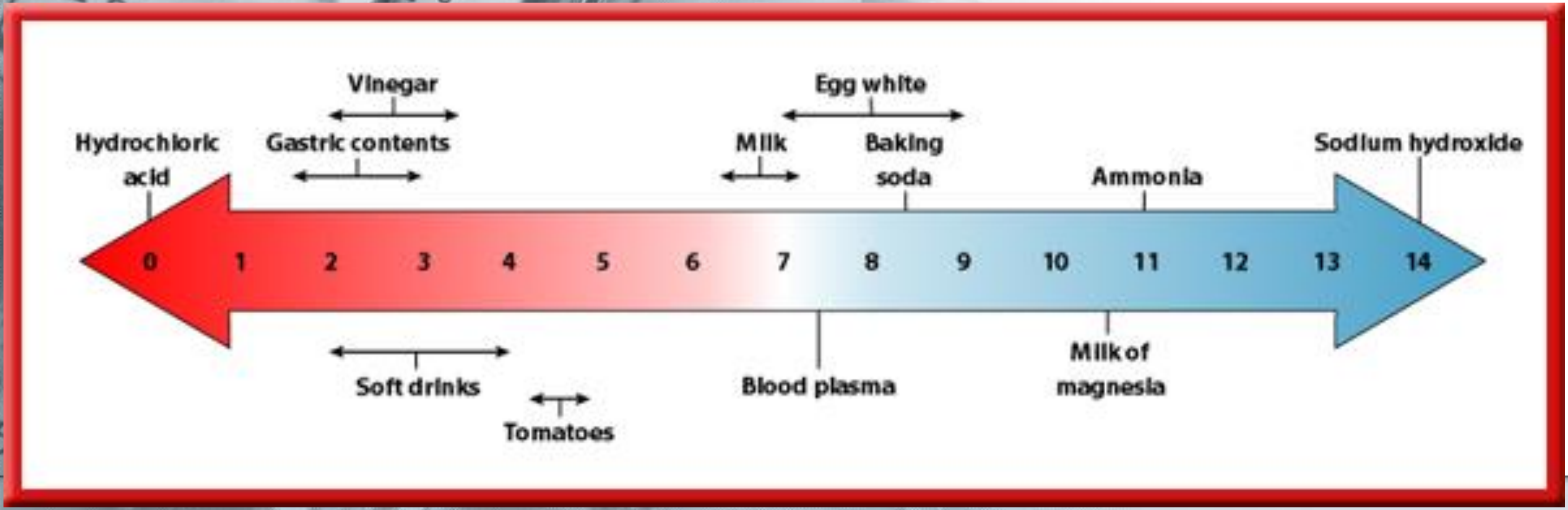
- **Bases give soaps, ammonia, and many other cleaning products some of their useful properties.**
- **The OH- ions interact strongly with certain substances, such as dirt and grease.**
- **Chalk and oven cleaner are examples of familiar products that contain bases.**
- **Your blood is a basic solution.**

pH Scale

- **pH** is a measure of how acidic or basic a solution is.
- The pH scale ranges from 0 to 14.
- Acidic solutions have pH values below 7
- A solution with a pH of 0 is very acidic.
- A solution with a pH of 7 is neutral.
- Pure water has a pH of 7.
- Basic solutions have pH values above 7.

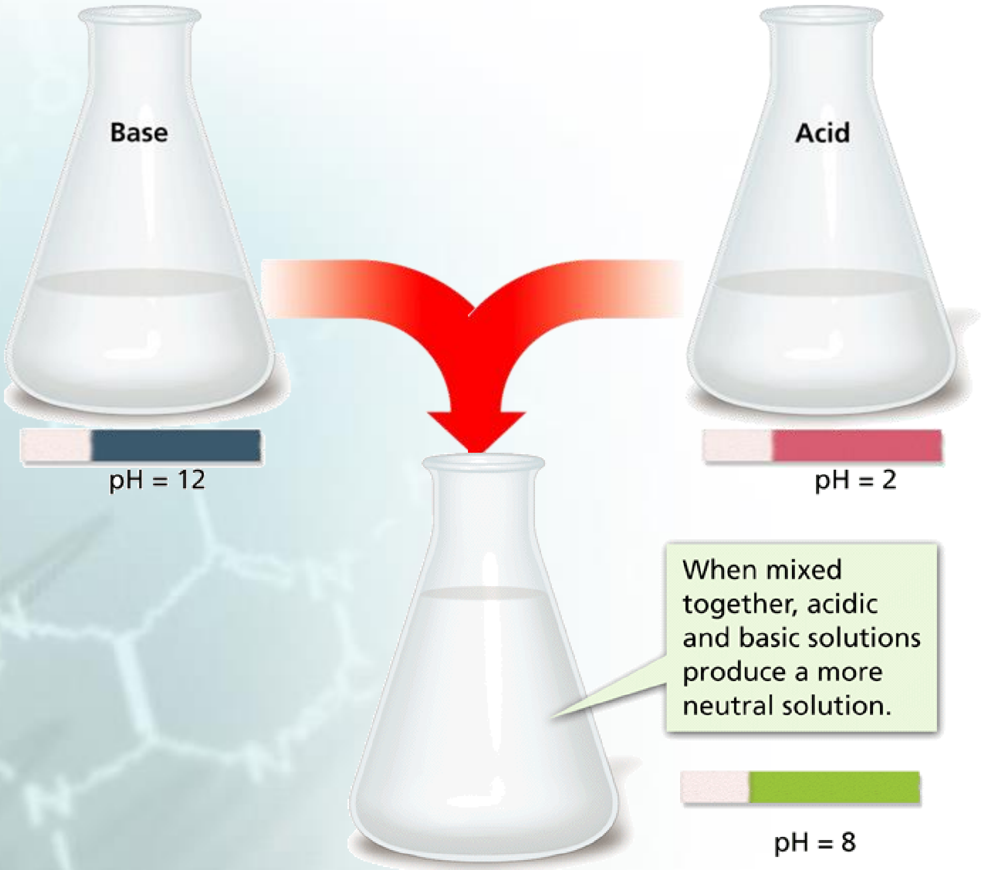
pH Scale

- A change of 1 pH unit represents a ten fold change in the acidity of the solution.
- For example, if one solution has a pH of 1 and a second solution has a pH of 2, the first solution is not twice as acidic as the second—it is ten times more acidic.



Acid – Base Reactions

- A reaction between an acid and a base is called *neutralization*. An acid-base mixture is not as acidic or basic as the individual starting solutions.

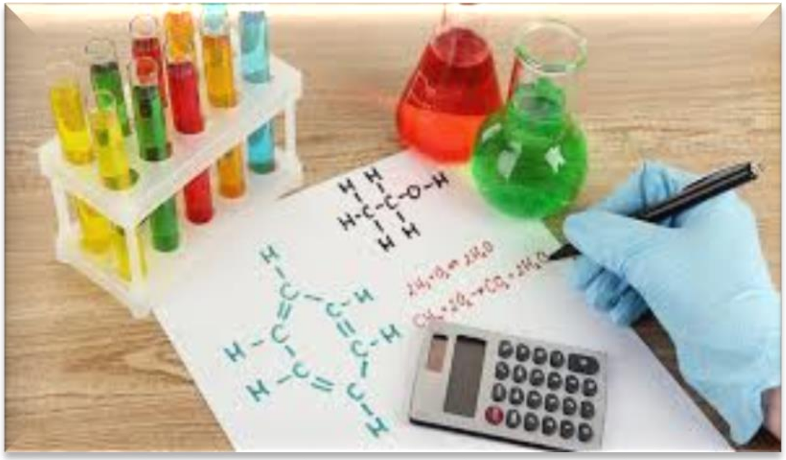


Acid – Base reactions

Common Salts	
Salt	**Uses**
Sodium chloride $NaCl$	Food flavoring; food preservative
Potassium iodide KI	Additive in "iodized" salt that prevents iodine deficiency
Calcium chloride $CaCl_2$	De-icer for roads and walkways
Potassium chloride KCl	Salt substitute in foods
Calcium carbonate $CaCO_3$	Found in limestone and seashells
Ammonium nitrate NH_4NO_3	Fertilizer; active ingredient in cold packs

Each salt listed in this table can be formed by the reaction between an acid and a base.

1)Analytical chemistry



- The analysis chemistry study

the determination of the chemical structure
Of the compounds or substance and in general it is include the:

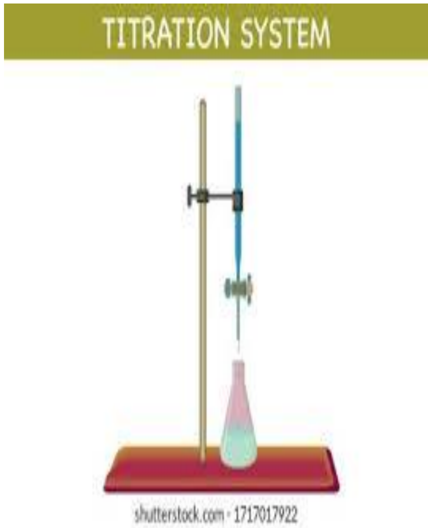
1. **Qualitative Analysis**

   Study what the elements and compounds constituted of the substance.

2. **Quantitative Analysis**

- It is determining of quantities of compound , or quantities of element include in the chemical component , or percentage weight of component of mixture

- **Quantitative analysis Include two classes** :
- **A \ Volumetric Analysis** : when reactants in solution are measured in volume unit) .
  It is include :
  1- Titration
  2- Gas analysis
  3- Instrument analysis

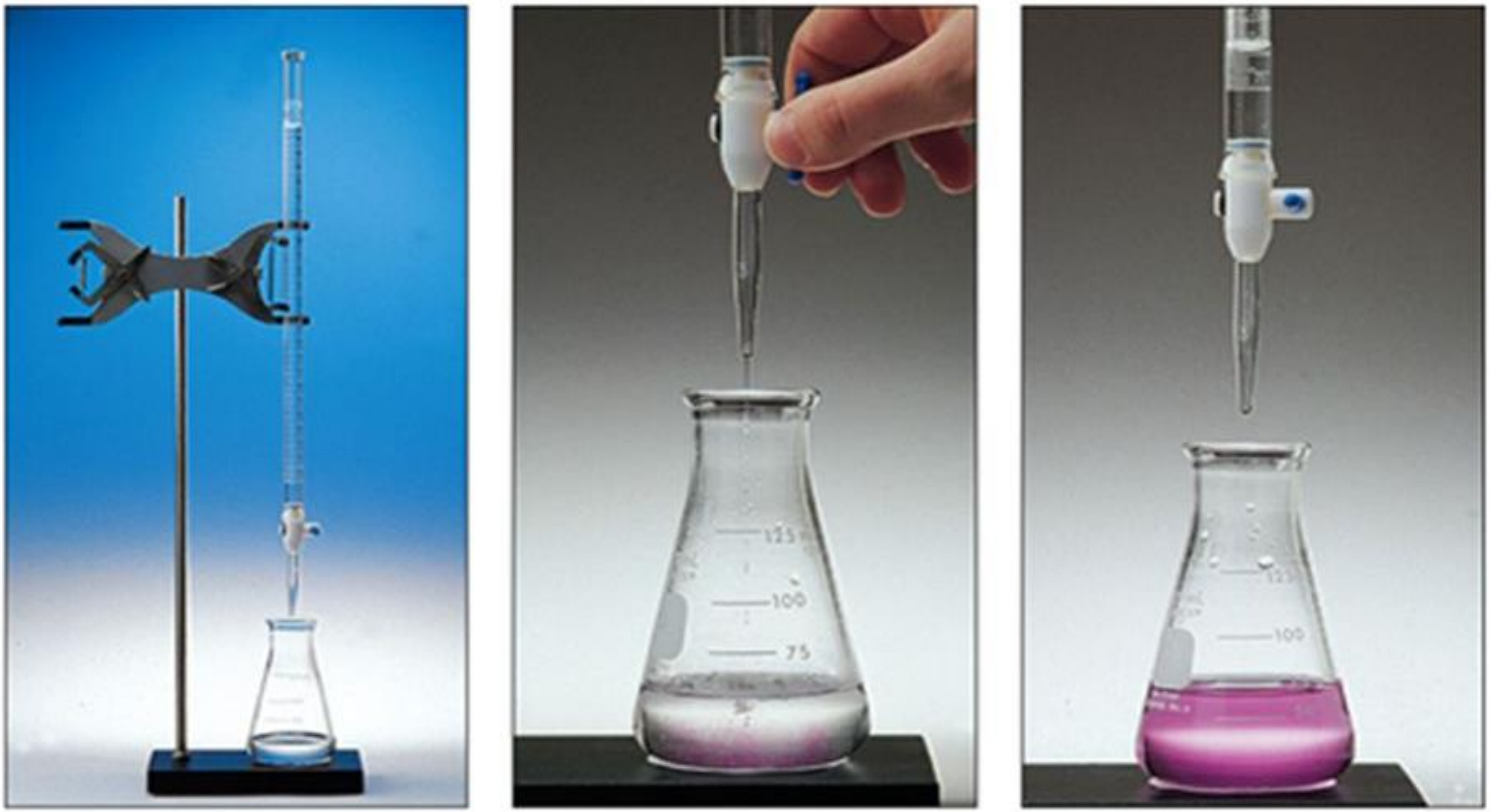


- **B \ Gravimetric Analysis:**
  when reactants in solution are measured in weight unit)
-

Titration of Acid and Base

- The titration of acids and bases is one of the most common ways of making a volumetric analysis .
- **Titration is the process of determining the volume of a standard solution that will react with a known quantity of the sample that is undergoing analysis .**
- **To make accurate measurements of volume , an apparatus called (burette) is used in titration , equivalent quantities of Acid and Base have reacted . There are certain substances called (indicators) that have one colure in an Acid solution and another colure in Basic solution**

ACID-BASE TITRATIONS



- In the process of **Acid – Base** titration a known volume either the **Acid** or the **Base** is placed in the flask and a few drops of indicator solution are added .
- The solution of **Base or Acid** from a burette is added slowly and constantly to the flask until the change in coloure of the indicator shows that **(end point)** has been reacted .
  Then the application law is :
- $$N_A \times V_A = N_B \times V_B$$
- Where A : Acid , B : Base

Quiz:

Answer these questions for SODIUM ATOM , the atomic number is 11

1. Write the symbol of the element on the periodic table
2. Write the electron configuration?
3. what is the period number?
4. what is the group number?
5. how many main shells?
6. how many valence electrons?
7. what subshell(s) does sodium have?

Lecture Five

Acid Base Titration

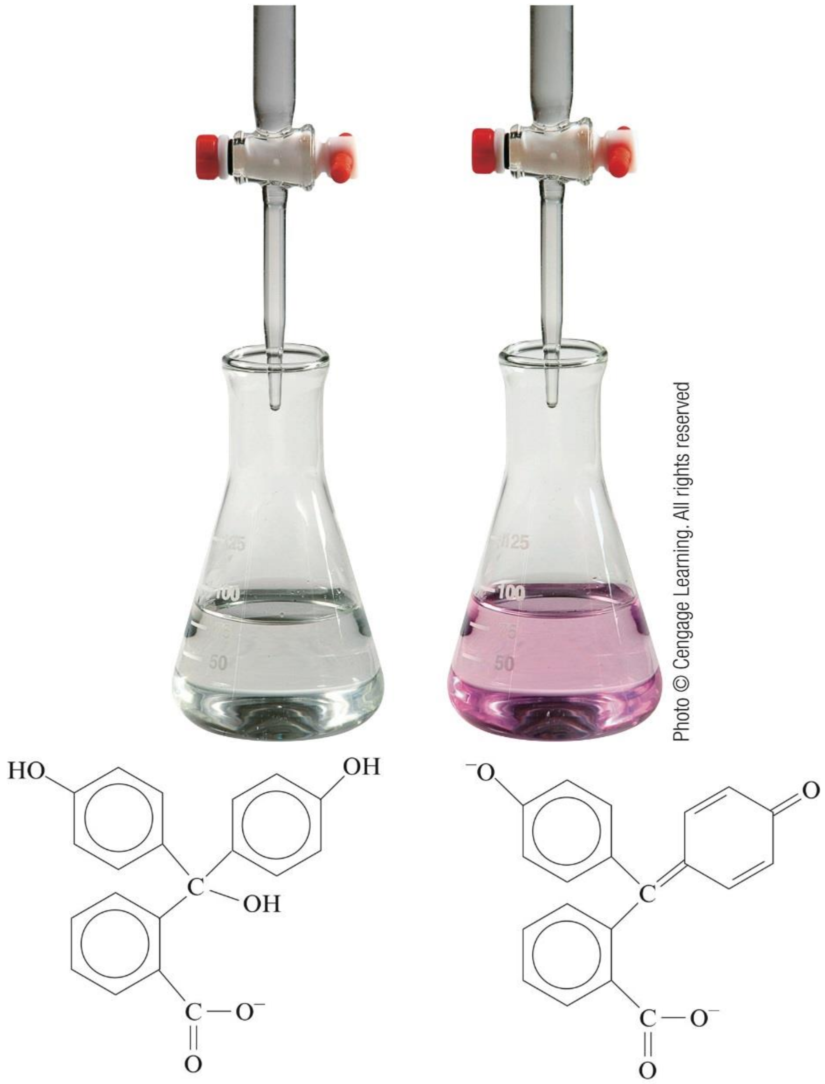
Indicators

The concentrations

The benefit of adding indicator at the titration:

- Marks the end point of a titration by changing color.
- The equivalence point is not necessarily the same as the end point (but they are ideally as close as possible).

The Acid and Base Forms of the Indicator Phenolphthalein



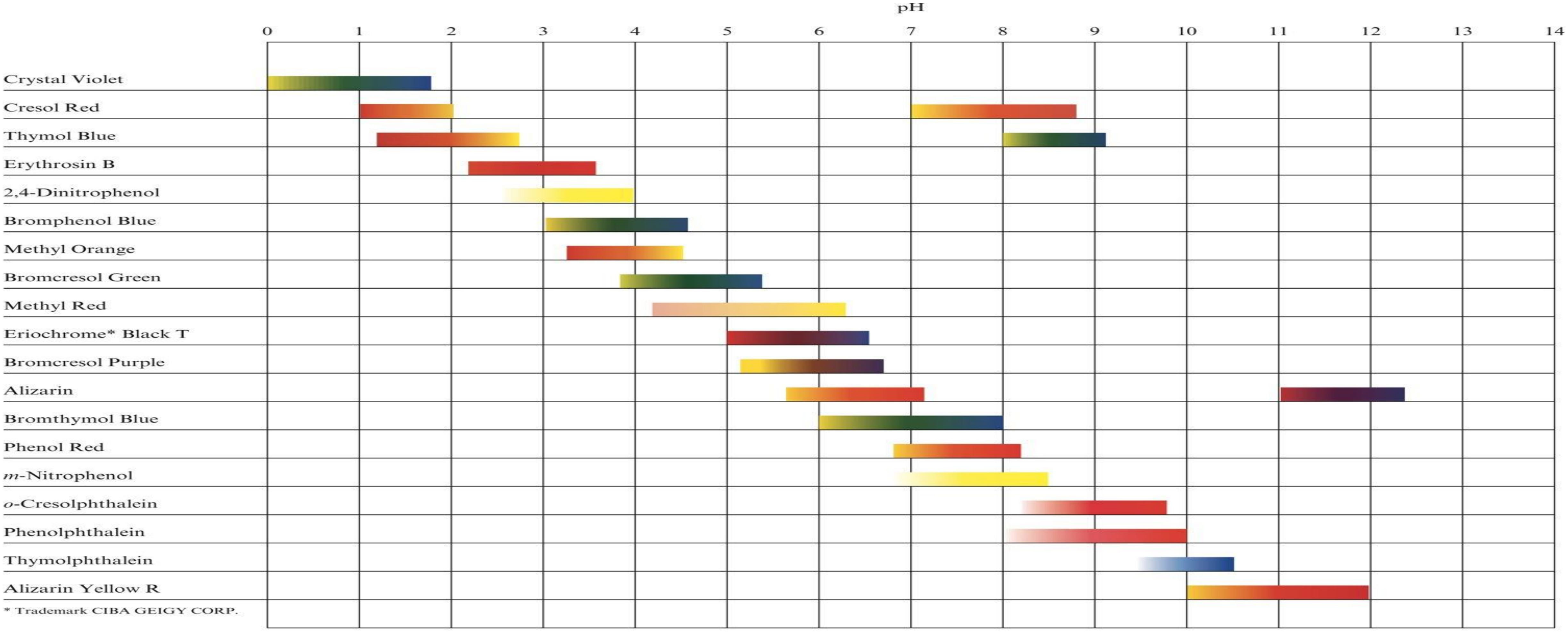
Colorless acid form, HIn

Pink base form, In^-

Acid-Base Indicators

The Methyl Orange Indicator is Yellow in Basic Solution and Red in Acidic Solution

Useful pH Ranges for Several Common Indicators



The pH ranges shown are approximate. Specific transition ranges depend on the indicator solvent chosen.


Made with KINEMASTER
Methyl orange
(Orange)
0:13 / 3:45

In a titration ,(46.3 ml) of (0.47 N) H2SO4 neutralized (35.4 ml) of unknown solution of (NaOH).calculate the Normality of (NaOH) solution.

- $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

$$\frac{N_1V_1}{n_1} = \frac{N_2V_2}{n_2}$$

$$\frac{0.47*46.3}{1} = \frac{N_2*35.4}{2}$$

$$N_2 = \frac{2*0.47*46.3}{35.4} = 1.23 \text{ N (NaOH)}$$

$N_{1,2}$=Acid,Base Conctration
$V_{1,2}$= Acid,Base Volume
$n_{1,2}$= No. of Acid,Base mols

The concentration of a solution

The **concentration** of a solution is a measure of the amount of solute that is dissolved in a given quantity of solvent.

- A **dilute solution** is one that contains a small amount of solute.
- A **concentrated** solution contains a large amount of solute.

Solution = solvent + solute

Methods Expressing Analytical Concentration and Volumetric :

1- Molarity

2- Normality

3- Molality

4- mole fraction

5- percentage weight

1-Molarity (M) المولارية

Molarity (*M*) is the number of moles of solute dissolved in one liter of solution.

To calculate the molarity of a solution, divide the moles of solute by the volume of the solution.

$$\text{Molarity } (M) = \frac{\text{moles of solute}}{\text{liters of solution}}$$

- Molarity (M) is the most common unit of concentration
- Molarity is an expression of moles/Liter of the solute.

Molarity

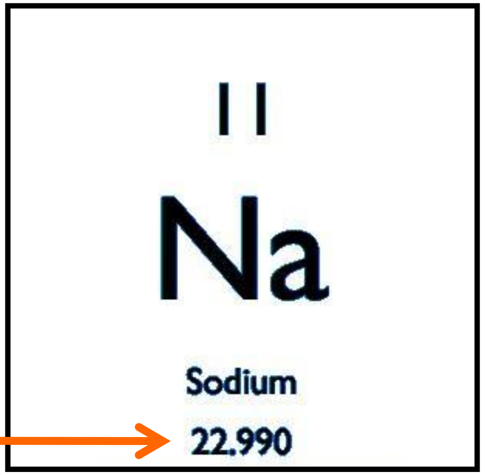
- To make a 0.5-molar (0.5*M*) solution, first add 0.5 gm of solute to a 1-L volumetric flask half filled with distilled water.

Swirl the flask carefully to dissolve the solute.

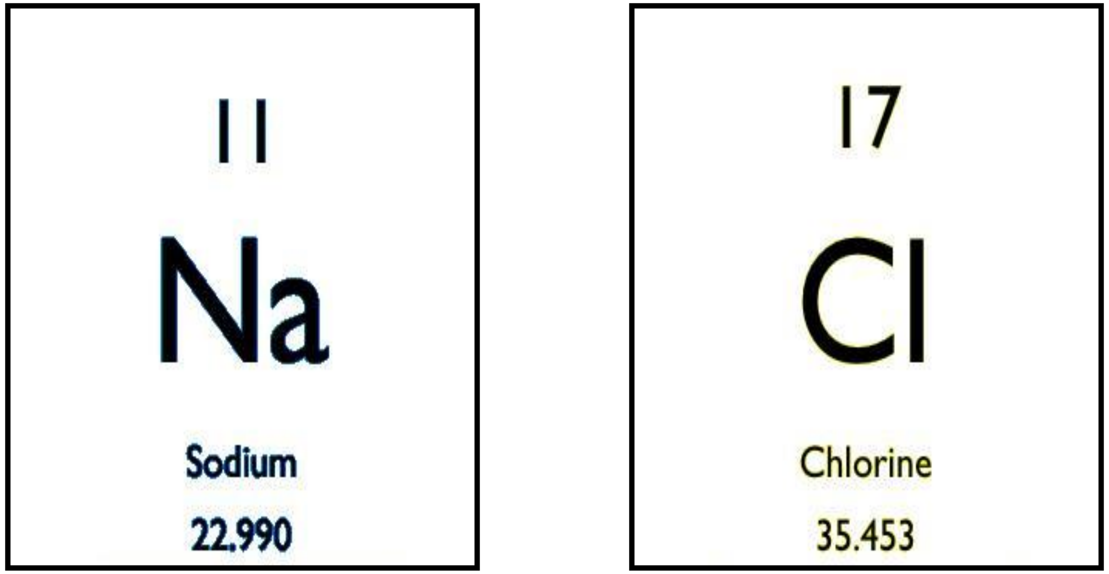
Fill the flask with water exactly to the 1-L mark.

- A mole is the SI unit (International System of Units) of number of particles and can be used as an expression of the molecular weight of a substance.

The formula weight of an element is expressed as grams/mole



⌘ The molar mass (molecular weight) of a compound can be calculated by adding the atomic weight of the individual elements.



22.99 + 35.45 = 58.44 g/mol

تركيز المحلول: هو قياس لكمية المذاب في كمية محددة من المذيب او المحلول.

المولارية (M): عدد مولات المذاب في لتر واحد من المحلول.

القانون المستخدم لحساب المولارية:

$$\text{المولارية} = \frac{\text{عدد مولات المذاب}\ (n)}{\text{حجم المحلول بالتر}\ V_{sol}(L)}$$

$$\text{Molarity (M)} = \frac{n}{V_{sol}(L)}$$

Molarity (M) المولارية

$$M = \frac{\text{no. of moles}}{V_L}$$

$$M = \frac{\text{wt.(g)}}{\text{Mo.wt.}} \times \frac{1}{V_L}$$

$$M = \frac{\text{wt.(g)}}{\text{Mo.wt}} \times \frac{1000}{V_{mL}}$$

Q:Calculate the Molarity of a solution that contains (100 gm) of (NaOH) dissolved in water to make (1500 ml) of solution .

$$M = \frac{wt.(g)}{Mo.wt} \text{ x } \frac{1000}{V_{mL}}$$

Moleculer weight= the sum of the atomic masses of the elements that make up a substance

Na=23,O=16,H=1

M.W for NaOH=23+16+1=40gm/mol

$$M = \frac{100}{40} \times \frac{1000}{1500} = 1.66 \quad mol/lit$$

Finding the Moles of Solute in a Solution

Household laundry bleach is a dilute aqueous solution of sodium hypochlorite (NaClO). How many moles of solute are present in 1.5 L of 0.70 *M* NaClO?

Calculating the Molarity of a Solution

Intravenous (IV) saline solutions are often administered to patients in the hospital. One saline solution contains 0.90 g NaCl in exactly 100 mL of solution. What is the molarity of the solution?

8. A solution has a volume of 2.0 L and contains 36.0 g of glucose ($C_6H_{12}O_6$). If the molar mass of glucose is 180 g/mol, what is the molarity of the solution?

Making Solutions

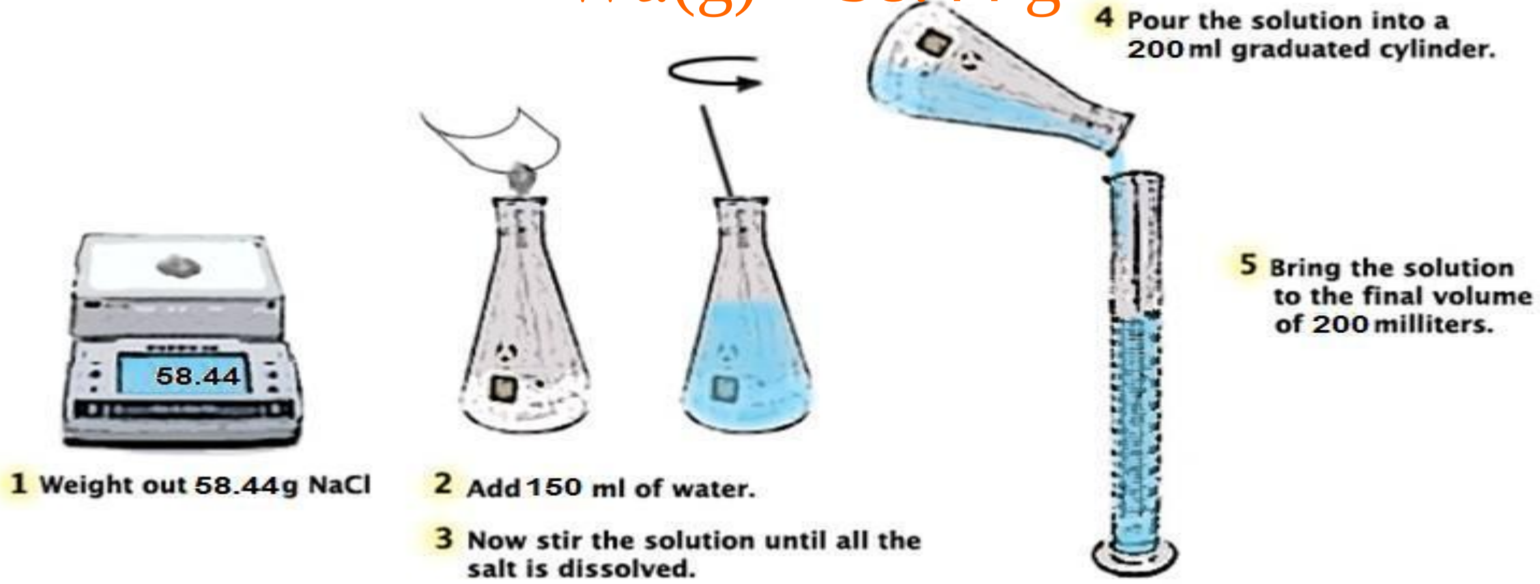
- **How many grams of NaCl would you need to prepare 200.0 mL of a 5 M solution?**

$$M = \frac{wt.(g)}{Mo.wt} \times \frac{1000}{V_{mL}}$$

$$Wt.(g) = M \times L \times Mo.wt$$

$$Wt.(g) = (5mol/L)\ (0.2L)\ (58.44g/mol)$$

$$Wt.(g) = 58.44\ g$$



Diluting Solutions

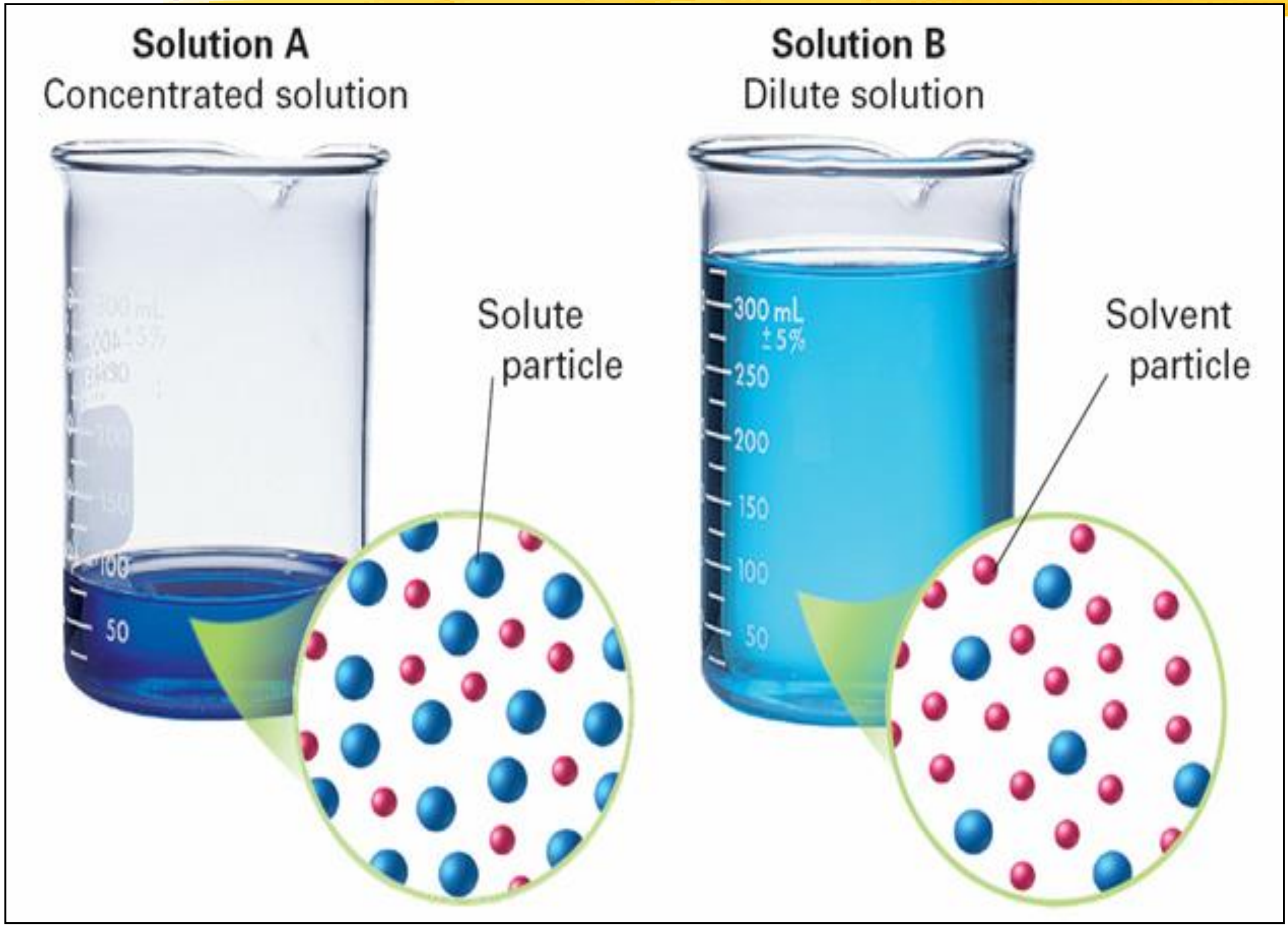
- Often once you have made a stock solution, you need to dilute it to a working concentration.
- To determine how to dilute the stock solution, use the formula:

$$C_1V_1 = C_2V_2$$

C_1 – concentration of stock
C_2 - concentration of diluted solution
V_1 – volume needed of stock
V_2 – final volume of dilution

Diluted ⟷ Concentrated

Making a Dilute Solution



- A **dilute solution** is one that contains a small amount of solute.
- A **concentrated solution** contains a large amount of solute.

Diluting Solutions

Example :

How many milliliters of a 5 M stock solution of NaCl are needed to prepare 100 ml of a 0.4 M solution?

$$C_1 \; V_1 = C_2 \; V_2$$

$$(5)\, V_1 = (0.4)(100)$$

$$V_1 = 8 \text{ ml}$$


Thank You For Listening

Normality (N)
Molality (m)
MOLEFRACTION (X_R)

Normality (N) العيارية

Normality is described as the number of gram equivalents of solute present in one liter of a solution.

$$N = \frac{\text{No. of g.eq}}{V_L}$$

$$N = \frac{\text{wt.(g)}}{\text{eq.wt.}} \times \frac{1}{V_L}$$

$$\text{eq.wt.} = \frac{\text{M.Wt}}{\text{no.of}_{\,H,OH}}$$

$$N = \frac{\text{wt.(g)}}{\text{eq.wt}} \times \frac{1000}{V_{mL}}$$

A solution was prepared by adding sufficient water to (100 gm) of HCl to make a solution of (0.5 L) , calculate the Normality of the solution .

At.wt. of Cl=35.5 , H=1

$$N = \frac{wt.(g)}{eq.wt.} \times \frac{1}{V_L}$$

M.W for HCl=1+35.5 = 36.5 gm/mol

$$eq.wt. = \frac{M.Wt}{no.of\ H,OH}$$

$$eq.wt. = \frac{36.5}{1} = 36.5$$

$$N = \frac{100}{36.5} \times \frac{1}{0.5}$$

=5.479 eq/lit

Calculate the normality of NaOH solution which contain 16 gm of NaOH in 400 ml of the solution .The atomic number for Na= 23, O=16,H=1

$$N = \frac{\text{No. of g.eq} * 1000}{VL}$$

$$\text{No. of g.eq} = \frac{Wt._{NaOH}}{eq.wt_{NaOH}}$$

$$NaOH \longrightarrow Na^{+} + OH^{-}$$

No. of mole of OH^{-} = 1 mole

$$eq.wt_{NaOH} = \frac{M.wt}{\text{No. of moles of } OH^{-}} = \frac{40}{1} = 40\ gm$$

$$\text{No. of g.eq} = \frac{16}{40} = 0.4\ Eq$$

$$N = \frac{0.4 * 1000}{400} = 1\ N\ (\text{or } Eq/L)$$

Molality المولالية

- **Molality** is the concentration of a solution expressed in **moles of solute per KILOGRAM of solvent**. Its symbol is ***m***, its units are **moles of solute/kg of solvent,** and it is written as 1.000 m NaOH for a one molal concentration solution of sodium hydroxide.

$$Molality(m) = \frac{moles\ of\ solute}{mass\ of\ solvent\ (kg)}$$

Example:

Find the molality of a solution made by adding 4.5 g of NaCl to 100 g of water.

MOLALITY

$$m = \frac{\text{mol solute}}{\text{kg solvent}}$$

- **Example:** What is the molality of a solution that contains 12.8 g of $C_6H_{12}O_6$ in 187.5 g water?

$$\frac{12.8\text{g } C_6H_{12}O_6}{} \times \frac{1\text{ mol}}{180.18\text{ g}} = 0.07104\text{ mol}$$

$$m = \frac{0.07104\text{ mol}}{0.1875\text{ kg}} = \boxed{0.379\text{ m}}$$

MOLEFRACTION الكسر المولي

The number of moles of solute to the number of moles of all solution (solute and solvent) .

$Xm= n1/n1+n2$

النسبة بين عدد مولات أحد مكونات المحلول (n) إلى مجموع مولات كل مكوناته (n_t).
وبفرض
أن لدينا ثلاث مواد (A,B,C) وعدد مولات هذه المواد (n_A, n_B, n_C) فإن الكسر المولي للمواد هو:

$$X_A = \frac{n_A}{n_t} \quad , \quad X_B = \frac{n_B}{n_t} \quad , \quad X_C = \frac{n_C}{n_t}$$

ومجموع
هذه الكسور المولية يساوي دائماً الواحد الصحيح:

$$\sum X = 1$$

$$X_A + X_B + X_C$$

$$\frac{n_A}{n_t} + \frac{n_B}{n_t} + \frac{n_C}{n_t} = \frac{\cancel{n}_t}{\cancel{n}_t} = 1$$

$$n = \frac{m}{Mw}$$

Example: Calculate the molar fraction of water, for NaCl in a solution containing 0.735 mol of Sodium chloride and 6 moles of water?

احسب الكسر المولي للماء، ولـــ NaCl في محلول يحتوي على 0.735 mol من كلوريد الصوديوم و 6 mole من الماء ؟

نحسب عدد المولات الكلي n_t :

$$n_t = n_{NaCl} + n_{H_2O}$$

$$n_t = 0.735 + 6$$

$$n_t = 6.735 \text{ mol}$$

$$\Rightarrow X_{H_2O} = \frac{n_{H_2O}}{n_t} = \frac{6}{6.735} = 0.89$$

$$X_{NaCl} = \frac{n_{NaCl}}{n_t} = \frac{0.735}{6.735} = 0.11$$

ويمكن حساب الكسر المولي لـ NaCl بطريقة أخرى، وهي :

$$\sum X = 1$$

$$X_{H_2O} + X_{NaCl} = 1$$

$$X_{NaCl} = 1 - X_{H_2O}$$

$$X_{NaCl} = 1 - 0.89$$

$$X_{NaCl} = 0.11$$

Home work

Q1:Calculate the Molarity of a solution that contains (100 gm) of (NaCl) dissolved in water to make (1500 ml) of solution .

Q2 : How many moles of solute are there in (500 ml) of (0.25 M) NaOH solution ?

Q3 : How many gram equivalent weights are there in(500gm) of (H3PO4)?

Q4 : A solution contain (500 gm) of KOH in (`1700 ml) water , what is Normality and Molarity?


THANK YOU
FOR
LISTENING

LEC-7- المحاضرة السابعة

-Relation Between Normality And Molarity
-Percent Of Solutions

Relation Between Normality And Molarity

العلاقة بين التركيز المولاري والتركيز العياري

$$N = M \times n_{(H^+,\ OH^-,\ \bar{e})}$$

Where,
n = the number of equivalents

example

1M solution of H_2SO_4 calculate the Normality for this solution

$$N_{H2SO4} = M * n_{of\ H}$$

$$N_{H2SO4} = 1 * 2$$

$$N_{H2SO4} = 2N$$

Percent Solutions

What are the ways to express the percent concentration of a solution?

Percent Of Solutions

طريقة النسبة المئوية

The concentration of a solution in percent can be expressed in three ways:

1. **ratio of the volume of the solute to the volume of the solution**

1-% (V/V) النسبة المئوية الحجمية.

تعرف بحجم المذاب بـال ml الموجود في 100mlمن المحلول

2. **ratio of the mass of the solute to the mass of the solution**

2- النسبة المئوية الوزنية% (W/W)

تعرف بوزن المذاب بالجرامات الموجودة في 100g من المحلول

3-ratio of the mass of the solute to the volume of the solution

3- النسبة المئوية الوزنية الحجمية % (W/V)

ويعبر عنها بوزن المادة بـ g المذابة في100ml من المحلول

⌘ Percent mass volume

$$(W/V)\% = \frac{wt.(g)\ \text{of solu.}}{V_{mL}\ \text{of sol.}} \times 100$$

Note:

Solution = solvent + solute

Percent Solutions

- Percent volume

$$\% \text{ volume } (V/V)\% = \frac{\text{volume solute (ml)}}{\text{volume solution (ml)}} \times 100$$

- Percent mass

$$\% \text{ mass } (W/W)\% = \frac{\text{mass solute (g)}}{\text{mass solution (g)}} \times 100$$

Note:

Solution = solvent + solute

Isopropyl alcohol (2-propanol) is sold as a 91% solution. This solution consist of 91 mL of isopropyl alcohol mixed with enough water to make 100 mL of solution.

Calculating Percent (Volume/Volume)

What is the percent by volume of ethanol (C_2H_6O, or ethyl alcohol) in the final solution when 85 mL of ethanol is diluted to a volume of 250 mL with water?

Analyze ***List the knowns and the unknown.***

Knowns
- volume of ethanol = 85 mL
- volume of solution = 250 mL

Unknown
- % ethanol (v/v) = ? %

- Percent by volume (% (v/v)) = $\frac{\text{volume of solute}}{\text{volume of solution}} \times 100\%$

Substitute the known values into the equation and solve.

$$\% \text{ (v/v)} = \frac{85 \text{ mL ethanol}}{250 \text{ mL}} \times 100\%$$

$$= 34\% \text{ ethanol (v/v)}$$

Percent Solutions

Example :

What is the percent by volume concentration of a solution in which 75.0 ml of ethanol is diluted to a volume of 250.0 ml?

$$\% (V/V) = \frac{\text{volume solute (ml)}}{\text{volume solution (ml)}} \times 100$$

$$= \frac{75.0 \text{ ml}}{250.0 \text{ ml}} \times 100 = 30.0\%$$

Percent Solutions

Example :

What volume of acetic acid is present in a bottle containing 350.0 ml of a solution which measures 5.00% concentration?

$$\% (V/V) = \frac{\text{volume solute (ml)}}{\text{volume solution (ml)}} \times 100$$

$$\mathbf{0.05 = \frac{x}{350.0\ ml}}$$

$$\mathbf{x = 17.5\ ml}$$

Mass Percent of Solute - Example

- Example – In a solution prepared by dissolving 24 g of NaCl in 176 g of solution, what is the % by mass of NaCl in solution?

- Solution:

Percent Solutions

Example :

Find the percent by mass in which 41.0 g of NaCl is dissolved in 331 grams of water.

$$\% \text{ mass (W/W)} = \frac{\text{mass solute (g)}}{\text{mass solution (g)}} \times 100$$

mass Solution = solvent mass + solute mass

mass Solution = 331g + 41g = 372g

$$\% \text{ (W/W)} = \frac{41 \text{ g}}{372 \text{ g}} \times 100 = 11.0\%$$

How to calculate the molar or standard concentration of a concentrated solution from the solution bottle?

كيفية حساب التركيز المولاري اوالعياري للمحلول المركز من العبوة

Example:

Calculate the volume and weight of 80% concentrated NaOH and a density of 1.42 g/ml that is needed to prepare 200 ml of a solution of concentration 8 M

احسب حجم ووزن هيدروكسيد الصوديوم NaOH المركز الذي تركيزه 80% وكثافته 1.42 g/ml اللازم لتحضير 200 ml من المحلول بتركيز 8 M . علماً بأن الاوزان الذرية : (H = 1, O = 16, Na = 23

ولحساب حجم محلول NaOH المركز (V_1) :

$$M_1V_1 = M_2V_2$$

$$V_1 = \frac{M_2V_2}{M_1} = \frac{8 \times 200}{28.4} = 56.34 \text{ ml}$$

ولحساب الوزن نتبع قانون الكثافة :

$$d = \frac{m}{V}$$

$$m = d \times V$$

$$m = 1.42 \times 56.34 = 80 \text{ g}$$