

CHEM 106

The Periodic Table
Atoms/Elements
↓
BONDS
↓
Compounds/Molecules

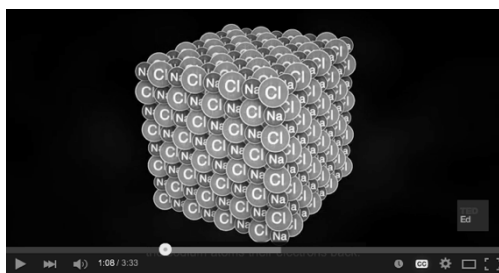
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Compounds & Chemical Bonds

Atoms in a compound (molecule) are in ratios of whole numbers with specific 3-dimensional arrangements due to attractive inter-atomic forces (Bonds). These bonds provide favorable energy states & spatial positions (lower energy & farther apart, but not too far, are better), which result in molecules having new chemical, physical, and biological properties.

<https://www.youtube.com/watch?v=NgD9yHSJ29I>

Chemical Bonds



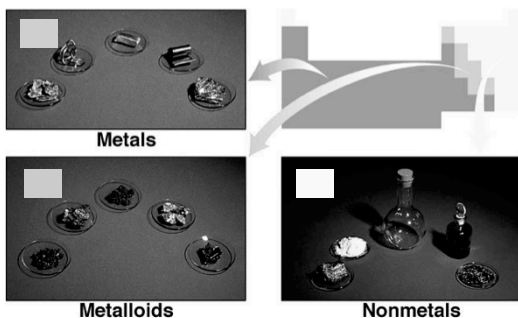
How atoms bond - George Zaidan and Charles Morton

Electrons, Configurations, & Bonds

Noble Gases and The Rule of Eight

- When a nonmetal and a metal combine, they form an **ionic bond**: Valence electrons of the metal are lost and the nonmetal gains these electrons to achieve a Noble gas electron configuration.
- When two nonmetals combine, they form a **covalent bond**: They share electrons to achieve a Noble gas electron configuration.

Metals, Metalloids, and Nonmetals



Periodic Properties

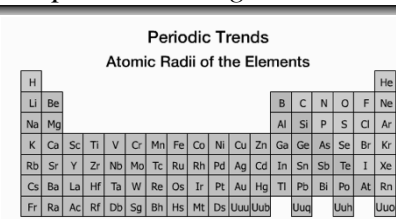
Periodic Properties

<http://chemconnections.org/general/movies/periodic-prop.MOV>

Periodic Table Properties & Organization

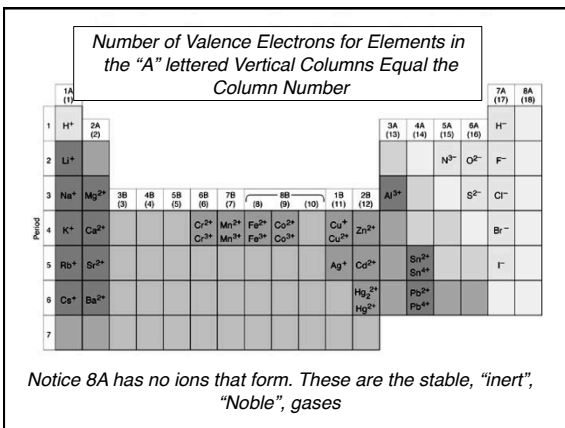
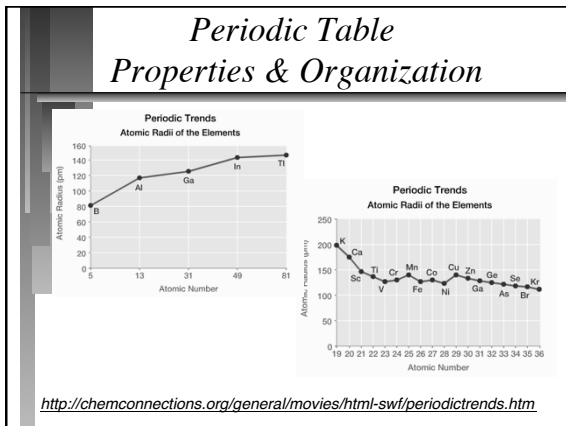
Periodic Trends

Atomic Radii of the Elements



H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Uub	Uub	Uuq	Uuq	Uuq	Uuq	Uuq	Uuq
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu				
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr				

<http://chemconnections.org/general/movies/html-swf/periodictrends.htm>



Ionic Bonds

- *Result from electrostatic attractions of closely packed, oppositely charged ions.*
- *Form when an atom which can easily lose electrons reacts with one which has a high electronegativity (electron affinity), that is, it can easily gain electrons.*
- *Eg. Mg and Cl; K and O*

The Relationship Between Ions Formed and the Nearest Noble Gas

5A (15)	6A (16)	7A (17)	8A (18)	1A (1)	2A (2)	3A (13)
		H ⁻	He	Li ⁺		
N ³⁻	O ²⁻	F ⁻	Ne	Na ⁺	Mg ²⁺	Al ³⁺
	S ²⁻	Cl ⁻	Ar	K ⁺	Ca ²⁺	
		Br ⁻	Kr	Rb ⁺	Sr ²⁺	
		I ⁻	Xe	Cs ⁺	Ba ²⁺	

Electron Configurations

Ionic Compounds

- ⦿ *Neutrally Charged*
- ⦿ *Eg. Salt: $\text{NaCl} \rightarrow 1 \text{Na}^+$ and 1Cl^-*
- ⦿ *What is the proportion of ions for a compound formed from Mg ion and chlorine?*
- ⦿ *Mg^{2+} and Cl^-*
- ⦿ *1Mg^{2+} combines with 2Cl^-*

MgCl_2

QUESTION

Predict the formula for the binary ionic compound formed by aluminum and oxygen.

- A) Al_2O_3 B) Al_3O_2 C) Al_2O D) AlO_2

ANSWER

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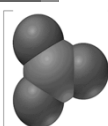
Ionic vs. Covalent Bonding



<http://chemconnections.org/general/movies/ionic-covalent.mov>

Polyatomic Ions

<http://chemconnections.org/general/chem120/polyatomics.html>



Carbonate ion
 CO_3^{2-}

Common Polyatomic Ions			
Ion	Name	Ion	Name
Hg_2^{2+}	Mercury(I)	NCS^-	Thiocyanate
NH_4^+	Ammonium	CO_3^{2-}	Carbonate
NO_2^-	Nitrite	HCO_3^-	Hydrogen carbonate (bicarbonate is a widely used common name)
NO_3^-	Nitrate	ClO_2^-	Hypochlorite
SO_3^{2-}	Sulfite	ClO_3^-	Chlorite
SO_4^{2-}	Sulfate	ClO_4^-	Chlorate
HSO_4^-	Hydrogen sulfate (bisulfate is a widely used common name)	ClO_4^-	Perchlorate
OH^-	Hydroxide	$C_2H_3O_2^-$	Acetate
CN^-	Cyanide	MnO_4^-	Permanganate
PO_4^{3-}	Phosphate	$Cr_2O_7^{2-}$	Dichromate
HPO_4^{2-}	Hydrogen phosphate	CrO_4^{2-}	Chromate
$H_2PO_4^-$	Dihydrogen phosphate	O_2^{2-}	Peroxide
		$C_2O_4^{2-}$	Oxalate

These polyatomic species involve both ionic and covalent bonding.

QUESTION

Which formula containing polyatomic ions is correct?

- A) $MgNO_3$ B) NH_4CO_3 C) $Na(PO_4)_3$ D) $Al_2(SO_4)_3$

ANSWER

Which formula containing polyatomic ions is correct?

- A) $MgNO_3$ B) NH_4CO_3 C) $Na(PO_4)_3$ D) $Al_2(SO_4)_3$

Electronegativity

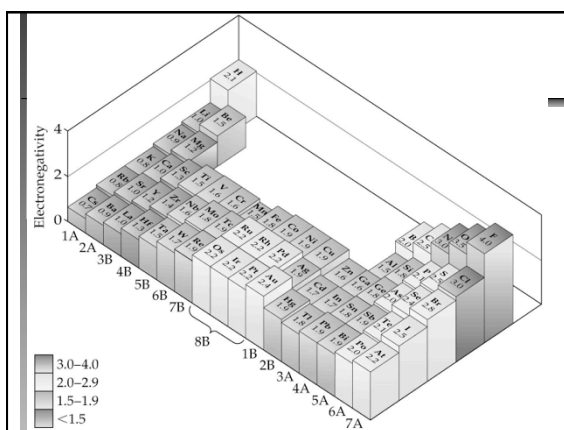


<http://chemconnections.org/general/movies/electronegativity.mov>

Electronegativity

Periodic Trends:
Electronegativity

<http://chemconnections.org/general/movies/Periodic-e.n.MOV>



QUESTION

For the elements Rb, F, and O, the order of increasing electronegativity is:

- A) $\text{Rb} < \text{F} < \text{O}$.
- B) $\text{Rb} < \text{O} < \text{F}$.
- C) $\text{O} < \text{F} < \text{Rb}$.
- D) $\text{F} < \text{Rb} < \text{O}$.
- E) none of these.

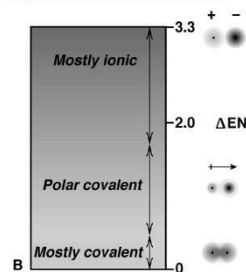
ANSWER

B) $\text{Rb} < \text{O} < \text{F}$.

Electronegativities increase moving up a column and to the right in the periodic table.

Boundary Ranges for Classifying Ionic Character of Chemical Bonds

ΔEN	IONIC CHARACTER
>1.7	Mostly ionic
$0.4-1.7$	Polar covalent
<0.4	Mostly covalent
0	Nonpolar covalent



QUESTION

Atoms having greatly differing electronegativities are expected to form:

- 1) no bonds.
- 2) polar covalent bonds.
- 3) nonpolar covalent bonds.
- 4) ionic bonds.
- 5) covalent bonds.

ANSWER

D) ionic bonds.

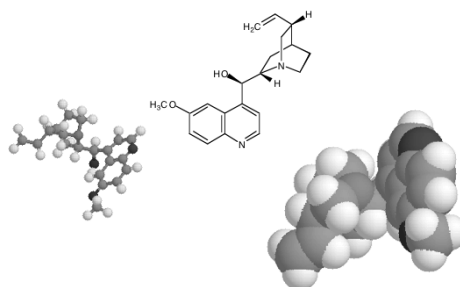
If two atoms have greatly differing electronegativities the more electronegative atom will pull on the bonding electrons so strongly the electrons will transfer from one atom to the other.

Chemical Formulas & Molecular Representations

Representing Substances

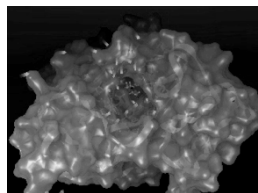
<http://chemconnections.org/general/movies/Representations.MOV>

Structural Representations of Quinine



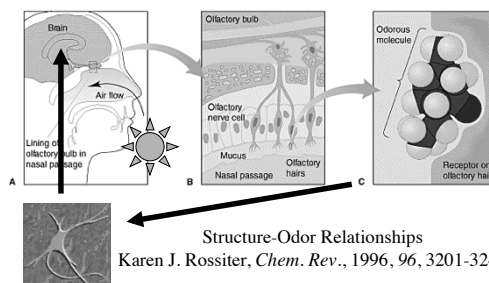
Proteins & Small Molecules

The interaction of a large protein bio-polymer, acetylcholinesterase, with a relatively small molecule of acetylcholine. A general process similar to the way that scientists that think we smell and many physiological processes.

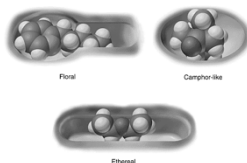


<http://chemconnections.org/general/movies/richard.mpg>

Detecting stuff we cannot see: the Sense of Smell Models, Theories & Interactions



Historical view of a few smell receptors.



4 October 2004

The Nobel Assembly at Karolinska Institutet has today decided to award

The Nobel Prize in Physiology or Medicine for 2004

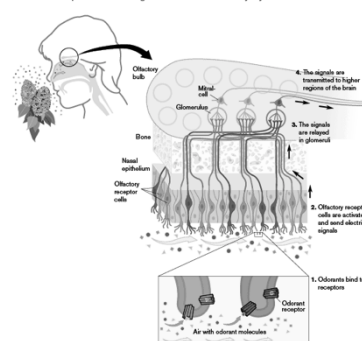
jointly to

Richard Axel and **Linda B. Buck**

for their discoveries of

"odorant receptors and the organization of the olfactory system"

Odorant Receptors and the Organization of the Olfactory System



Shapes & Interactions: Mirror Images & Smell

