Covalent Bonding

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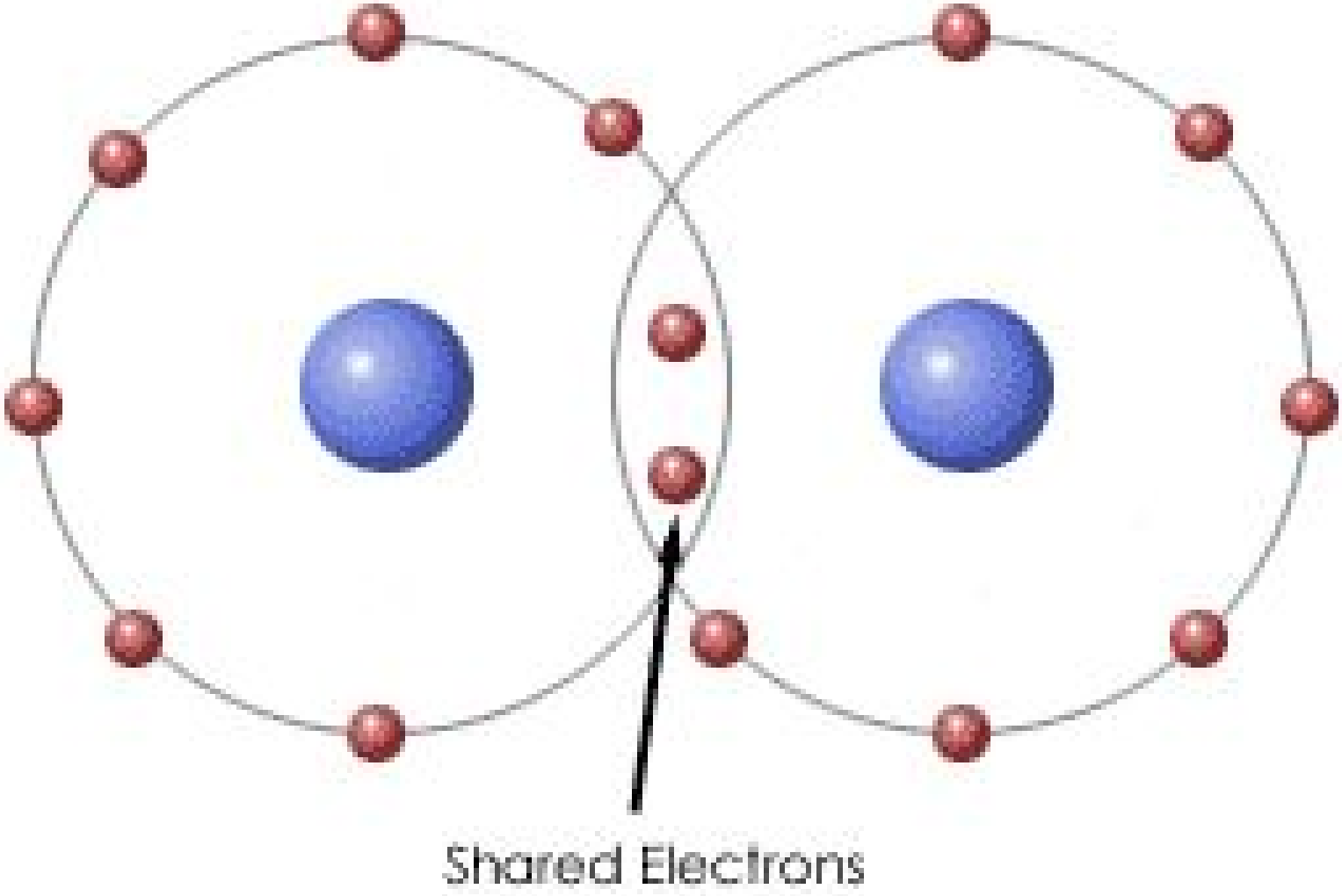
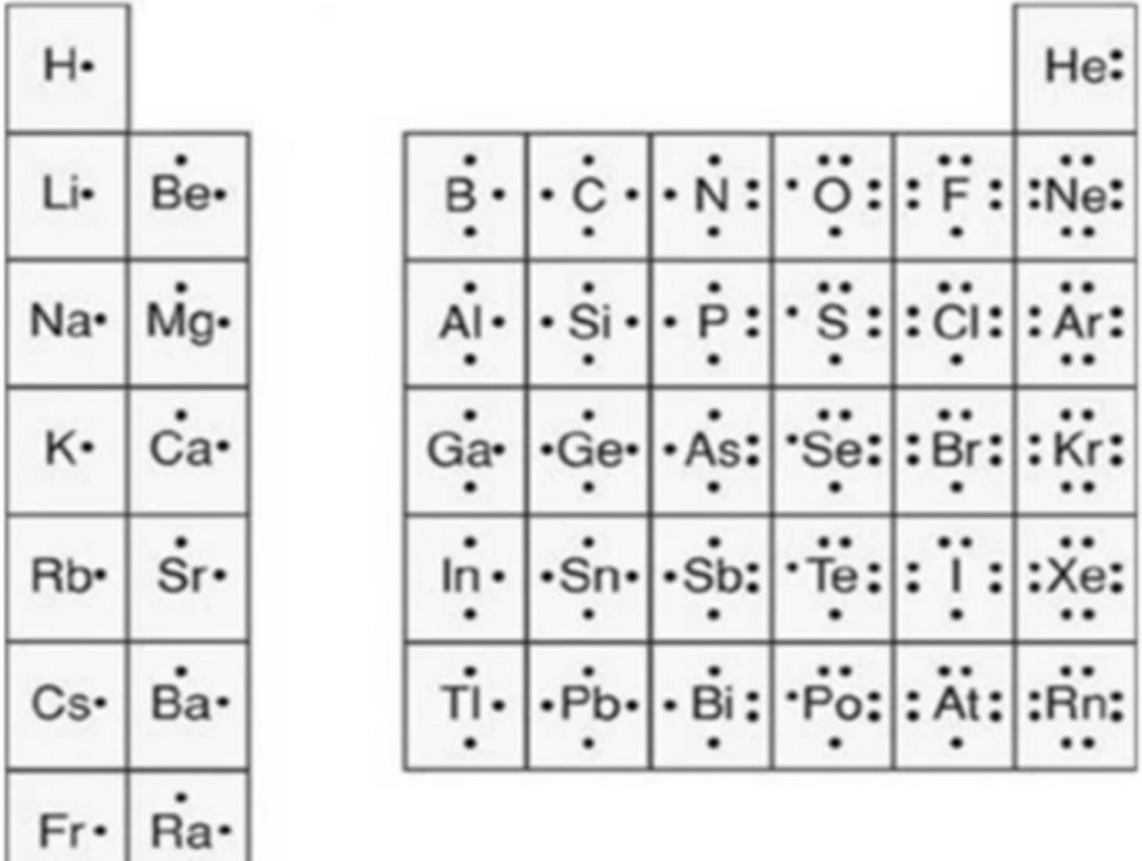
What is Covalent Bonds ?


Shared Electrons

Lewis Diagram

Lewis Electron-Dot Formulas




WE'RE A FULL OCTET!
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Lewis Electron-Dot Formulas

1. Calculate the total number of valence electrons - *if it is a polyatomic anion, add the charge in; if it is a polyatomic cation, subtract the charge*

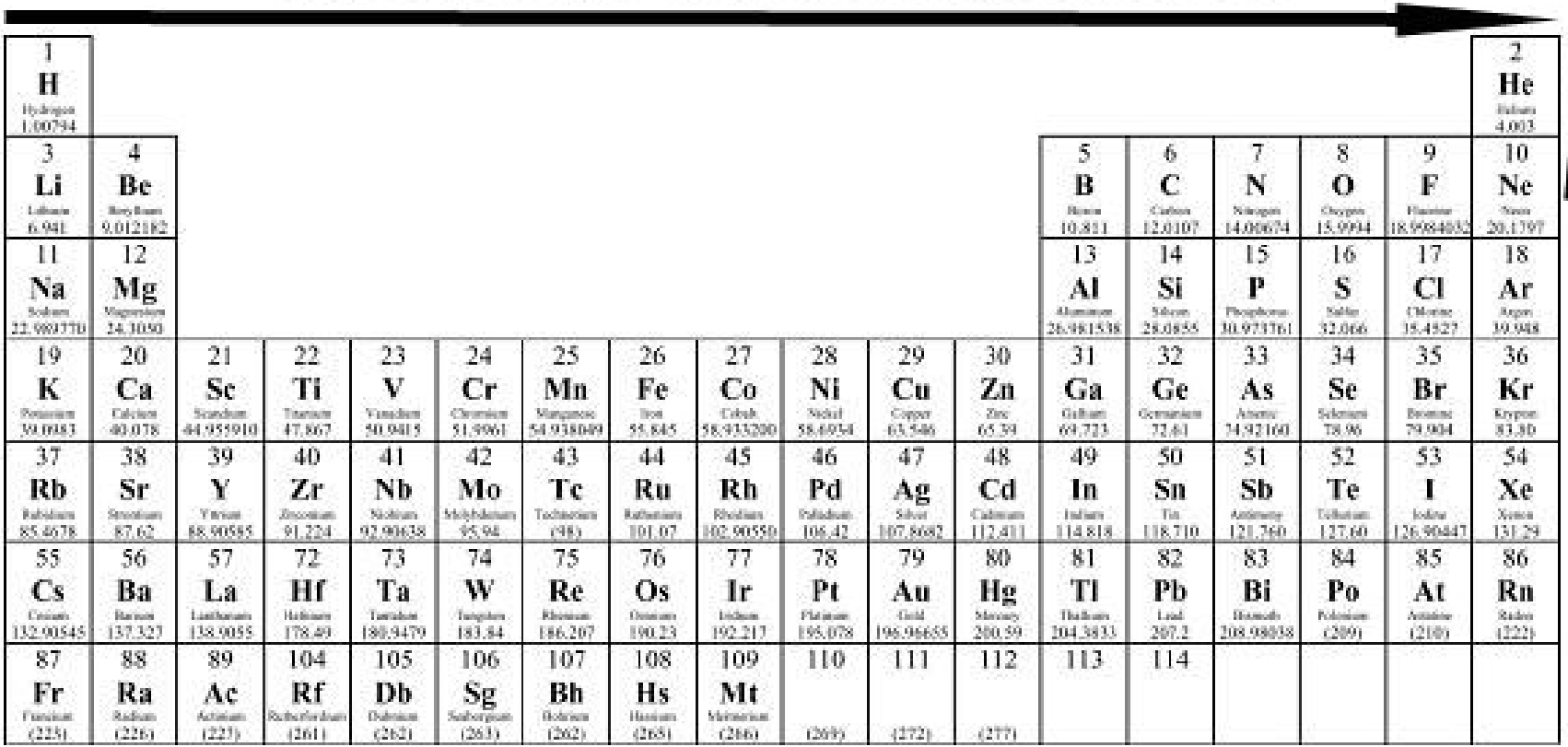
2. Draw the skeleton structure - *the central atom is typically the least electronegative atom* - connect the rest of the atoms with single bonds

3. Distribute the electrons to the atoms surrounding the central atom/atoms to satisfy the octet rule

4. Distribute the remaining electrons as pairs to the central atom/atoms - *if there are fewer than 8 e^- on a central atom, this suggests a double or triple bond!*

Non-polar or polar ?

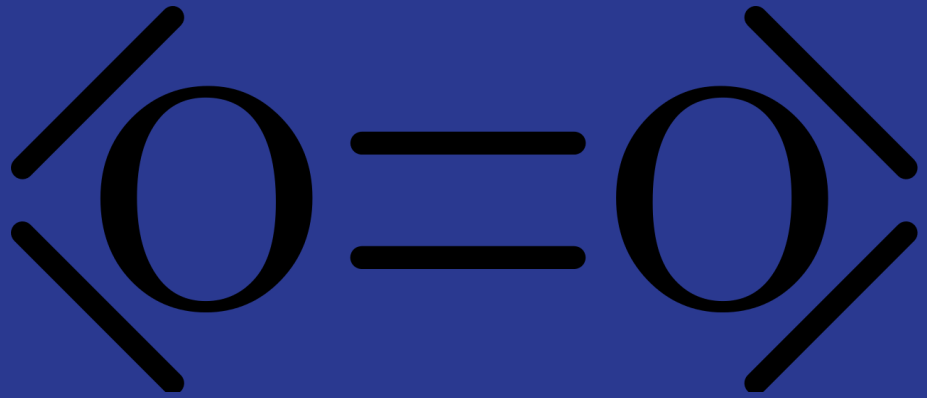
Increasing Electronegativity

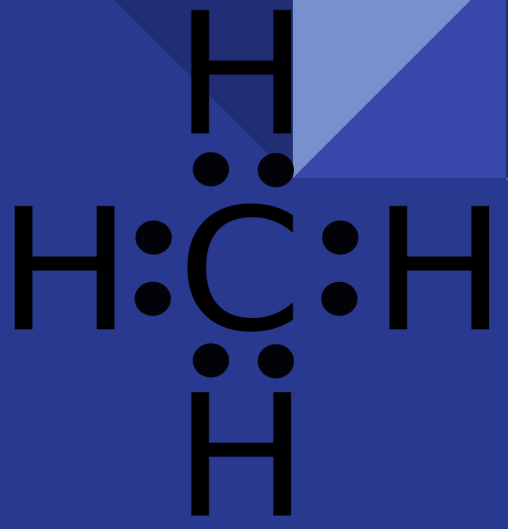


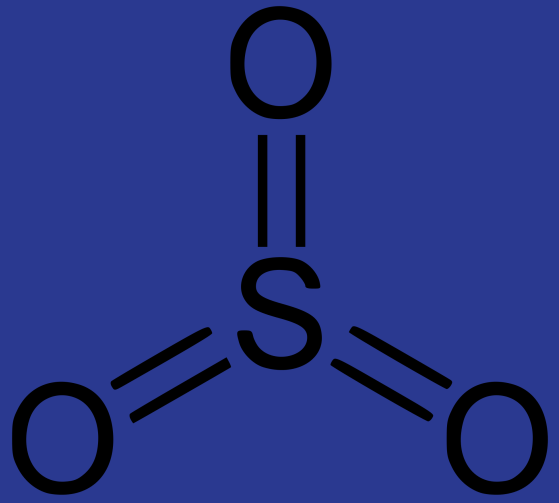
1 H Hydrogen 1.00794																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
11 Na Sodium 22.989770	12 Mg Magnesium 24.3050											13 Al Aluminum 26.981538	14 Si Silicon 28.0855	15 P Phosphorus 30.973761	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 44.955910	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938049	26 Fe Iron 55.845	27 Co Cobalt 58.933200	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	57 La Lanthanum 138.9055	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)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

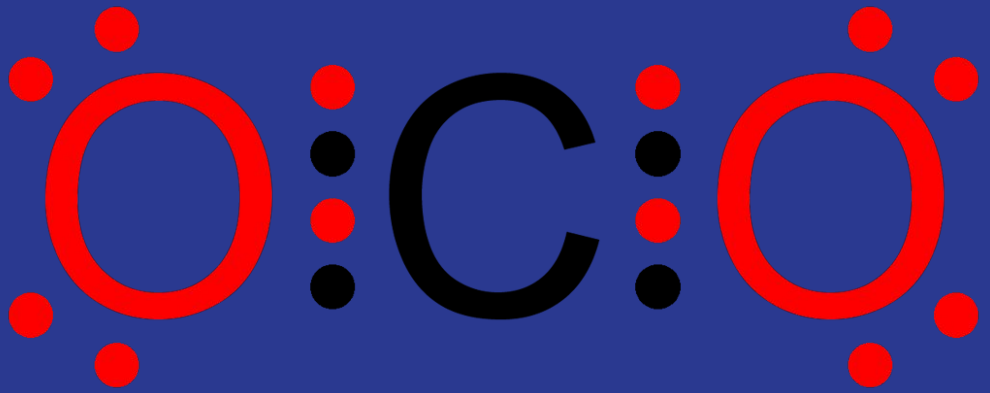
Non-polar

Difference of electronegativity
(0~0.5)


O
O

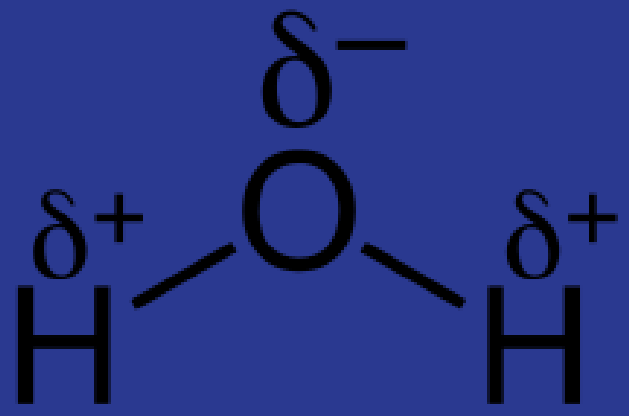

H
H
C
H
H

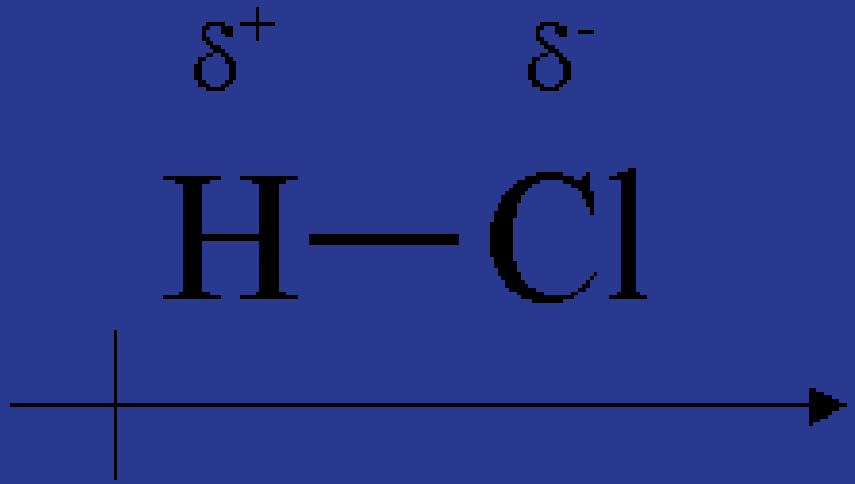

O
S
O
O


O
C
O

Polar

Difference of electronegativity
(0.5~1.7)


δ−
δ+
O
δ+
H
H


δ+
δ-
H—Cl

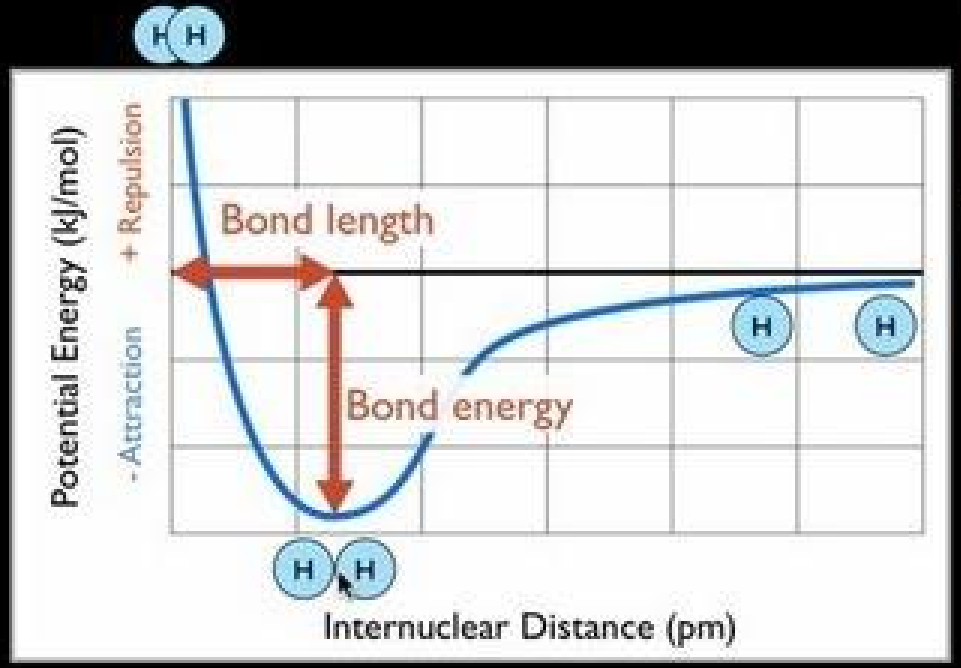
Bond length

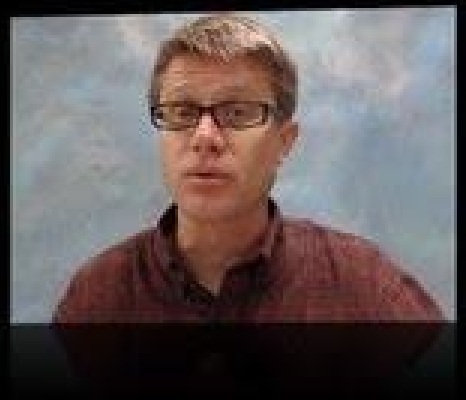
Bond length or bond distance is the average distance between nuclei of two bonded atoms in a molecule. It is a transferable property of a bond between atoms of fixed types, relatively independent of the rest of the molecule.

Bond energy

The bond energy is a measure of the amount of energy needed to break apart one mole of covalently bonded gases.

Atom Potential Energy vs. Internuclear Distance



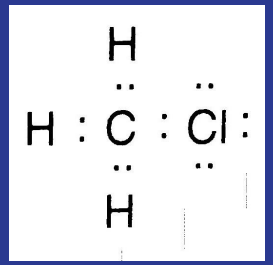


Questions

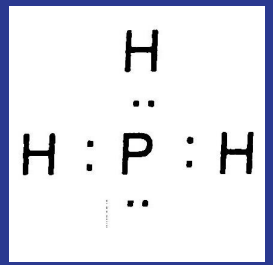
1. Construct Lewis Diagram
    a. CH_3Cl
    b. PH_3
    c. SiF_4
    d. PO_4^{3-}
    e. ClO_4^-
    f. CO_3^{2-}

Solutions:

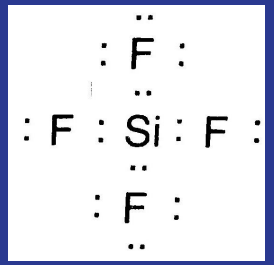
a.



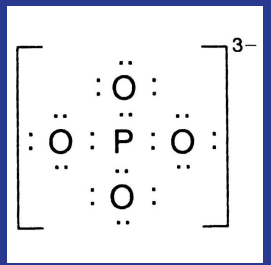
b.



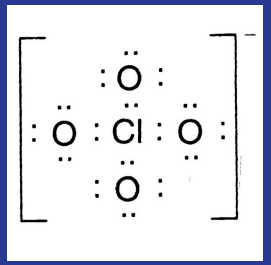
c.



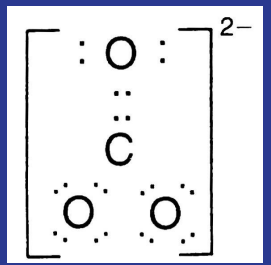
d.



e.



f.



2. Calculate the Formal Charge

a. CH_3Cl
b. PH_3
c. SiF_4
d. PO_4^{3-}
e. ClO_4^-
f. CO_3^{2-}

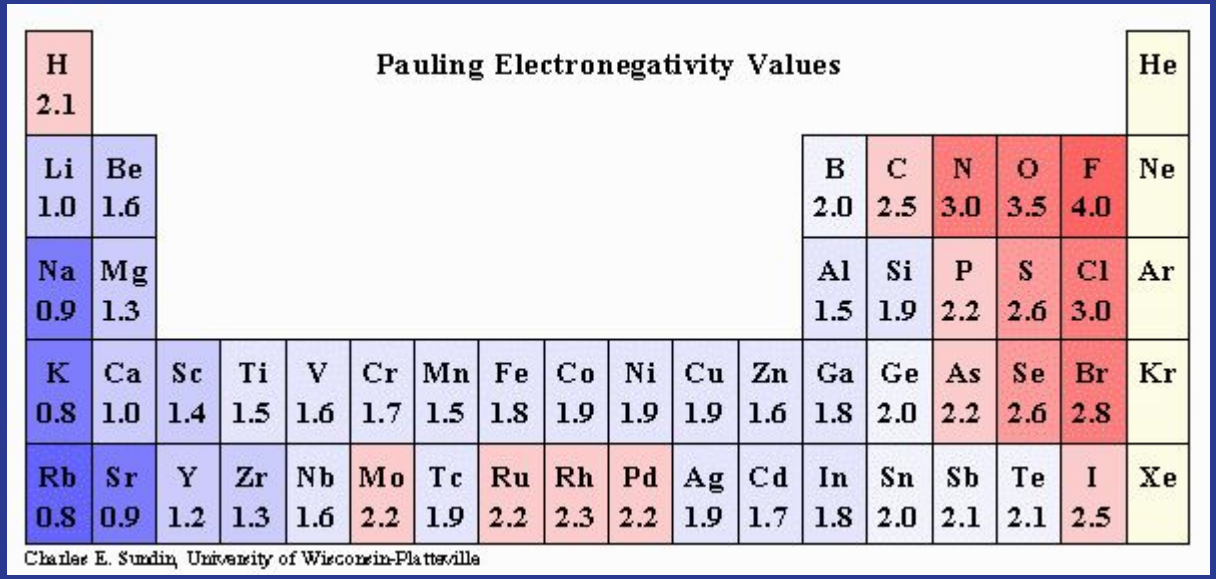
$$FC = V - N - \frac{B}{2}$$

Solutions:

a. All zero
b. All zero
c. All zero
d. P = +1
e. Cl = +3
f. C = 0

3. Which bond Is More Polar?

a. C-N or C-O
b. H-Cl or H-Br
c. S-O or S-Br
d. H-S or H-O
e. P-Br or S-Br



Solutions:

a. C-O
b. H-Cl
c. S-O
d. H-O
e. P-Br

Challenging Question

How to determine the relationship between type of bonds and the bond strength?

EXPLANATION OF MISCONCEPTIONS

When two electrons are sharing between two atoms to form a covalent bond, it is called a single bond.

For example, one Cl_2 molecule has one single bond. An O_2 molecule has one double bond of 4 shared electrons.

A single bond is represented by a single dash between atoms.

COMMON BONDS

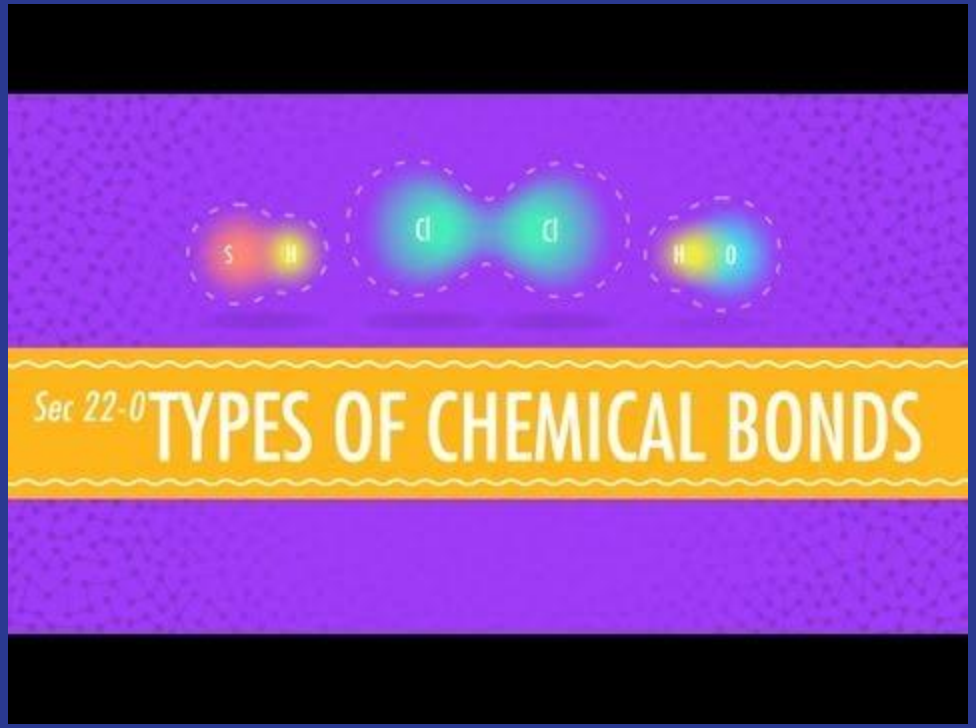
Cl-Cl
F-F

O=O
O=C=O

N≡N

Normally, we think that if two atoms has an electronegativity higher than 1.7 than they would form a ionic bond and it they have a different electronegativity less than 1.7, then they will form a covalent bond.

- Not all molecules that have covalent bonds are nonpolar.
- Not all chemical bonds between a metal and a nonmetal are ionic bonds. For example, ($AlCl_3$) has covalent bonds.


S
H
Cl
Cl
H
O
Sec 22-0
TYPES OF CHEMICAL BONDS