Ch 8: Covalent Bonding

**Molecular Compounds:**

* Compound composed of molecules
  + Molecule- neutral group of atoms joined together by covalent bonds
  + Diatomic molecule- molecule consisting of 2 atoms

(H2, N2, 02, F2, Cl2, Br2, I2)

**Molecular Compounds Properties:**

* Solids, liquids or gases
* Nonmetals
* Low melting and boiling points
* Poor conductors of electricity
* Generally insoluble in water

Covalent Bonding:

* Shares electrons b/w nonmetals to obtain octet
* Electron dot (Lewis) structure- represents the shared pair(s) of electrons
* Unshared pair (lone pair)-pair of valence electrons not shared b/w atoms
* Structural formula-represents the covalent bonds by dashes

Single Covalent Bonds:

* 2 atoms share a pair of electrons
* Ex. H2O

2H + O O H or O H

H H

Hydrogen atoms oxygen atom water molecule

Double Covalent Bonds:

* 2 atoms share 2 pairs of electrons
* Ex. O2

O + O → O O or O O

Oxygen atom Oxygen atom oxygen molecule

Triple Covalent Bonds:

* 2 atoms share 3 pairs of electrons
* Ex. N2

N + N → N N or N N

Nitrogen Nitrogen nitrogen molecule

atom atom

Exceptions to the Octet Rule:

* Molecules whose total number of valence electrons is an odd #

Ex. NO2 , ClO2  , NO

* Molecules more or less valence electrons than a complete octet

ex. B, Al, P, S

Bond strength and lengths:

|  |  |  |
| --- | --- | --- |
| Bond Type | Strength | Length |
| Single | Weakest | Longest |
| Double |  |  |
| Triple | Strongest | Shortest |

**Drawing Electron Dot (Lewis) Structures:**

**Draw Electron Dot (Lewis) structure of Iodomethane, CH3I.**

1. **Determine the type and number of atoms in the molecule**. *The formula shows 1 carbon atom, 1 iodine atom, and 3 hydrogen atoms.*
2. **Write the electron-dot notation for each type of atom in the molecule.** *Carbon is from Group 14 and has 4 valence electrons.* *Iodine is from Group 17 and has 7 valence electrons. Hydrogen has 1 valence electron.*

C I H

1. **Determine the total number of valence electrons in the atoms to be combined.**

C 1 x 4e- =

I 1 x 7e- =

H 3 x 1e- =

1. **Arrange the atoms to form a skeleton structure for the molecule. If carbon is present, it is the central atom. Otherwise, the least-electronegative atom is central (except for hydrogen, which is never central). Then connect the atoms by electron-pair bonds.**

H

H C I

H

1. **Add unshared pairs of electrons so that each hydrogen atom shares a pair of electrons and each other nonmetal is surrounded by eight electrons.**

H

H C I

H

**6a.) Count the electrons in the structure to be sure that the number of valence**

**electrons used equals the number available.** *There are eight electrons in the 4*

*covalent bonds and 6 electrons in the 3 unshared pairs, giving the correct total of 14*

*valence electrons.*

**6b.**) **If too many electrons have been used, subtract 1 or more lone pairs until the total number of valence electrons is correct. Move one or more lone electron pairs to exisiting bonds b/w non-hydrogen atoms until the outer shells of all atoms are completely filled**

*(ex. CO*

C O

**HW: Practice Problems**: Draw Ammonia, NH3 ; Hydrogen sulfide, H2S ; Formaldehyde, CH2O; Carbon dioxide, CO2; Hydrogen cyanide, HCN

8.3 Bonding Theories:

**VSEPR Theory**:

* Valence-shell electron-pair repulsion theory
* 3-D molecule shape
* Electron pairs = as far apart from each other as possible (repulsion)

**Predicting Shapes:**

* + A= central atom
  + B= atoms bonded to central
  + E= Unshared pair of electrons-– strongly repel bonding pairs, pushing them away

ex. H**2**0 = 4 pairs of electrons (2 bonded, 2 unshared –

BENT arrangement (AB**2**E**2**) not Linear (AB, AB2)

* + Double and triple bonds – viewed as single bonds

**9.3 Naming and Writing formulas for Molecular compounds:**

Molecular Formulas:

* Chemical formula of a molecular compound
* Shows how many atoms of each element a molecule contains
* Subscript- indicates the # of atoms of each element in the molecule

ex. Water molecule = 2 hydrogen atoms and 1 oxygen atom

Molecular formula= H2O

**Binary molecular compound:**

* Composed of 2 elements – both nonmetals

**Naming Molecular Compounds:**

* Prefixes indicate the number of atoms

Ex. Cl2O8 = *di*chlorine *octo*xide

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Molecular compounds Prefixes | | | | | | | | | | |
| Prefix | Mono | Di | Tri | Tetra | Penta | Hexa | Hepta | Octa | Nona | Deca |
| **#** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

* Omit prefix *mono* for the first element if it is solo

Ex. CO = carbon monoxide

* Second element-ending of the element’s name dropped

and *ide* added

Ex. CO = carbon monox*ide*

**Writing formulas for molecular compounds:**

* Prefixes = the subscript

Ex. Dinitrogen tetroxide = N2O4

8.4 [Polar Bonds and Molecules](https://www.youtube.com/watch?v=PVL24HAesnc&index=24&list=PL8dPuuaLjXtPHzzYuWy6fYEaX9mQQ8oGr):

Bond Polarity:

* Nonpolar Covalent bond-
  + Atoms in the bond pull equally
  + Balanced distribution of charge
* Polar Covalent bond-
  + Atoms in the bond pull unequally
  + Uneven distribution of charge -Dipole (partial) = neg. and pos. ends
  + More electronegative = gains a neg. charge
  + Less electronegative = gains a pos. charge
  + δ – greek letter delta denotes partial charges (δ+, δ –)

ex. δ+ δ –

H Cl

* + points to more electronegative atom

ex.

H Cl

Ionic or Covalent:

* Electronegativity- determines the degree in which bonding b/w elements

is ionic or covalent

|  |  |  |
| --- | --- | --- |
| Electronegativity Differences and Bond Types | | |
| Electron negativity difference range | Bond Type | Example |
| 0.0 –0.4 | Nonpolar covalent | H-H |
| 0.4 – 1.0 | Moderately polar covalent | H-Cl |
| 1.0 – 1.7 | Very polar covalent | H-O |
| ≥ 1.7 | Ionic | Na+Cl- |

[Intermolecular Forces](https://www.youtube.com/watch?v=S8QsLUO_tgQ): force of attraction b/w molecules

* Dipole interactions–
  + polar molecules are attracted to one another
* Hydrogen Bonds-
  + A Strong Dipole interaction in which H, F, O, N are involved
* Dispersion forces–
  + Occurs b/w all atoms and molecules
  + Electrons in continuous motion – creates temporary dipoles creating a weak attraction (held together for an instant)