Lewis Structures & VSEPR

Lewis Structure

- Lewis Structures – shows how the _____ are arranged among the atoms of a molecule
- There are rules for Lewis Structures that are based on the formation of a _____
- Atoms want to achieve a _____ configuration

Octet & Duet Rules

- Octet Rule – atoms want to have _____ valence electrons
- Duet Rule – H is the exception. It wants to be like He & is stable with only _____ valence electrons

Steps for drawing Lewis Structures

- Sketch a simple structure with a central atom and all attached atoms
- Add up all of the valence electrons for each individual atom
  - If you are drawing a Lewis structure for a negative ion add that many electrons to create the charge
  - If you are drawing a Lewis structure for a positive ion subtract that many electrons to create the charge

Steps for drawing Lewis Structures

- Subtract 2 electrons for each bond drawn
- Complete the octet on the central atom & subtract those electrons
- Complete the octet on the surrounding atoms & subtract those electrons
- Get your final number
  - If 0 → you are done!
  - If + → add that many electrons to the central atom
  - If - → need to form multiple bonds to take away that many electrons

Bond Types

- _____ bonds (σ) – single covalent bond
- _____ bonds (Π) – occur when multiple bonds are formed
- Single bond – sigma
- Double bond – 1 sigma & 1 pi
- Triple bond – 1 sigma & 2 pi

Bond length & Strength

- As the number of bonds increases, the bond length _____
- The shorter the bond, the _____ the bond

Examples

- CCl_4

Examples

- HF

Examples

- NH_3

Examples

- NO^+

Exceptions to the octet rule

- Sometimes the central atom violates the octet rule and has more or less than 8 valence electrons
- Keep using the same rules to draw Lewis Structures

Examples

- SF_4

Examples

- ICl_3

Examples

- XeF_4

Examples

- ICl^-

Resonance

- When more than one Lewis Structure can be written for a particular molecule
- _____ – all possible Lewis structures that could be formed
- The actual structure is the _____ of all of the structures
- You MUST show all structures!

Examples

- SO_3

Examples

- NO_2^-

Examples

- NO_3^-

Formal Charge

- Formal charges can be used in 1 of 2 ways…

1. Suggest where the _____ are
2. Help select the most _____ structure from a set of resonance structures

1 - Suggest where the charges are

- Formal charge =

Example

- Calculate the formal charge on each element in the carbonate ion
- CO_3^{2-}

2 - Help select the most plausible structure from a set of resonance structures

- When choosing the most likely resonance structure

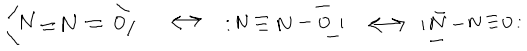
1. Most likely – All formal charges are _____
2. Next likely – All formal charges add up to _____
3. Next likely – Formal charges are closest to _____
4. Next likely – _____ charge is on most electronegative atom

Example

- Which of the following resonance structures is most likely for CH_2O and why?

Another Example

- Which is the most likely structure for N_2O?



VSEPR Theory

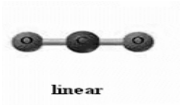
- VSEPR Theory _____
- The structure around a given atom is determined by minimizing the _____
- The electrons and elements bonded to the central atom want to be _____ as possible

VSEPR Steps

1. Draw the Lewis structure for the molecule
2. Count the total number of things that are around the central atom to determine the **electron pair geometry**
3. Imagine that the lone pairs of electrons are invisible and describe the molecular shape

2 Electron Pairs

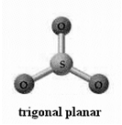
- If there are 2 things attached to the central atom, the shape is linear



- Bond angle = 180°

3 Electron Pairs

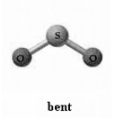
- If there are 3 electron pairs the shape will be trigonal planar



- Bond angle = 120°

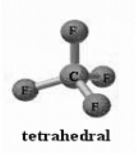
3 electron pairs

- Now imagine that you have 3 electron pairs, but one is just a lone pair (invisible) what would it look like then?



4 electron pairs

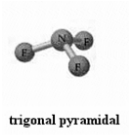
- If there are 4 electron pairs, the shape will be tetrahedral



- Bond angle = 109.5°

4 electron pairs

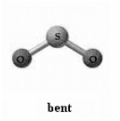
- What if 1 of the electron pairs is a lone pair (invisible)? What would it look like then?



- Trigonal Pyramidal

4 electron pairs

- What if there are 2 lone pairs (invisible)? What would it look like then?



- bent

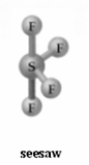
5 electron pairs

- If there are 5 electron pairs the shape will be Trigonal Bipyramidal

- Bond angles = 90º & 120º

5 electron pairs

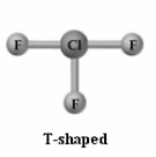
- What is there is 1 lone pair (invisible)



- Seesaw

5 electron pairs

- What is there are 2 lone pairs (invisible)



T-shaped

- T-shaped

6 electron pairs

- If there are 6 electron pairs the shape will be octahedral

octahedral

- Bond angle = 90°

6 electron pairs

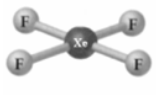
- What if there is 1 lone pair (invisible)?

square pyramidal

- Square pyramidal

6 electron pairs

- What if there are 2 lone pairs (invisible)



square planar

- Square planar