Chapter 7 Part 1

Dr. Turner

Covalent Bonding

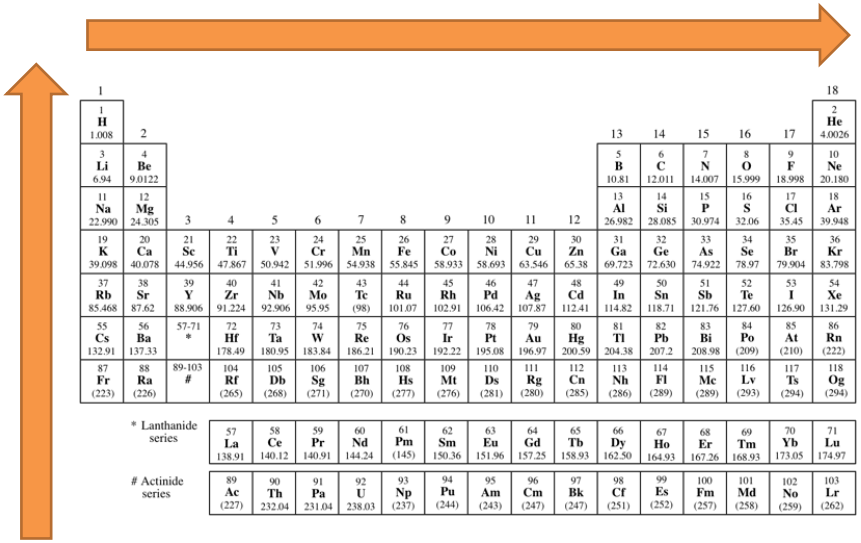
- Atoms held together by sharing of electrons to fulfill the octet rule
- Primarily between nonmetals
- Involves electron sharing

Covalent Bonding

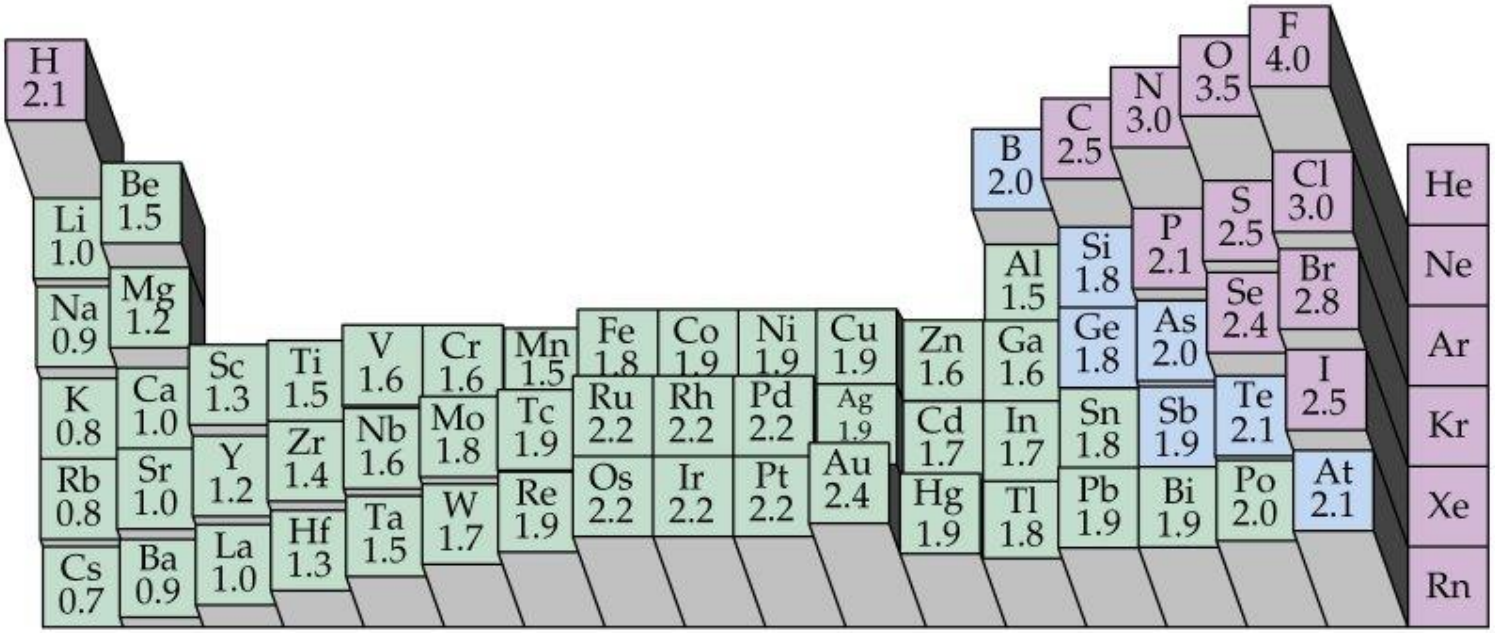
- As the atoms come together to form a molecule and share electrons, they become more stable.
- Atoms gain, lose, or share electrons to achieve a stable, noble-gas electron configuration, ns^2np^6.
- This general trend to achieve eight valence electrons is known as the octet rule.
- Hydrogen and helium, which have valence electrons in the first shell, $1s^2$, follow the duet rule.

Electronegativity

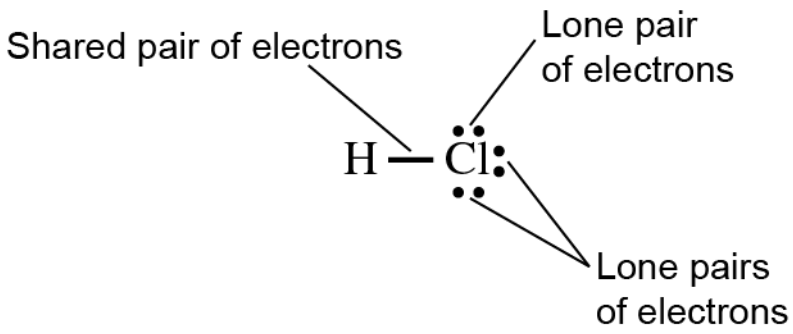
- The ability of an atom in a molecule to attract electrons to itself within a bond is called electronegativity
- Metals generally have low electronegativities
- Nonmetals generally have high electronegativities
- Electronegativity generally increases going up and to the right excluding the noble gases.



Electronegativity

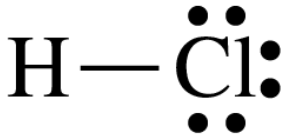


Lewis Structure of HCl



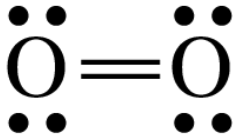
- An H atom has one valence electron and a Cl atom has seven.
- In the HCl molecule, these two atoms share one pair of electrons.
- H has access to a second electron (duet rule) via the shared pair.
- Cl has three unshared pairs, also referred to as lone pairs and one shared pair, forming a covalent bond.

Single, Double, and Triple Bonds



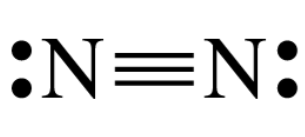
Single bond
2 shared electrons

One shared pair



Double bond
4 shared electrons

Two shared pairs



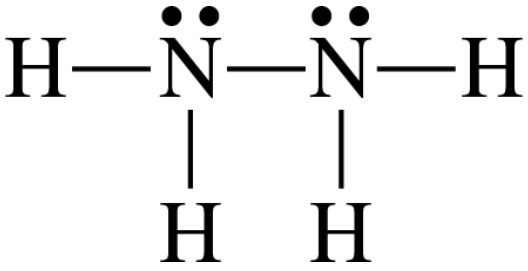
Triple bond
6 shared electrons

Three shared pairs

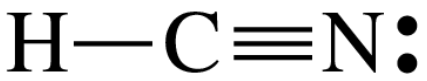
Shared and Unshared Electrons

Identify the numbers of shared electrons and unshared electrons in these Lewis structures.

A. hydrazine, N_2H_4



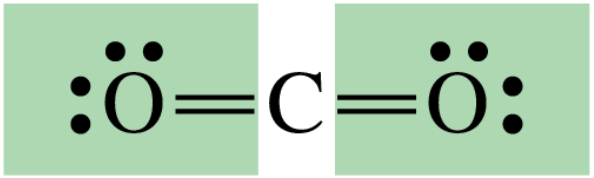
B. hydrogen cyanide, HCN



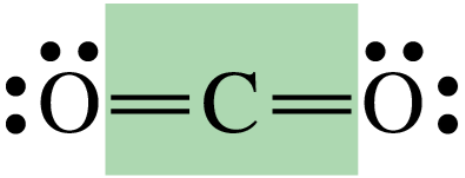
Characteristics of Valid Lewis Structures

- The number of electrons in a Lewis structure equals the total number of valence electrons in the atoms of the molecule.
- Atoms in a Lewis structure obey the octet/duet rule.

Octets in Carbon Dioxide



(a)

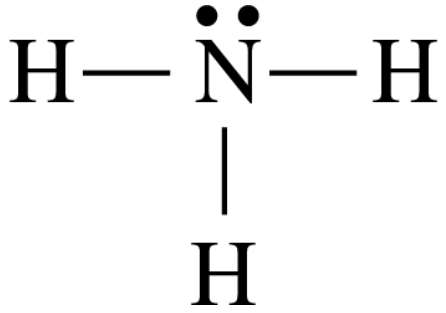


(b)

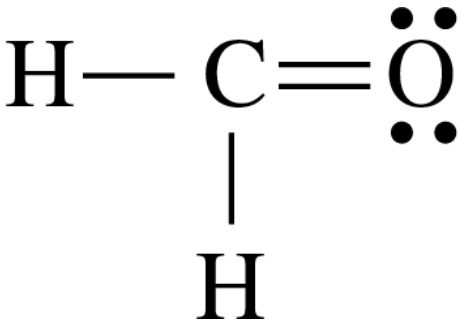
Verifying Valid Lewis Structures.

Verify that these are valid Lewis structures.

A. ammonia, NH_3



B. formaldehyde, H_2CO



Drawing Lewis Structures

1. Count the valence electrons.
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

Drawing Lewis Structures (F_2)

1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

Drawing Lewis Structures (CF_4)

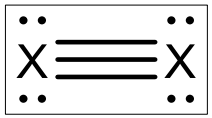
1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

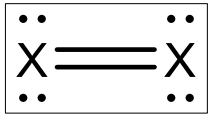
Drawing Lewis Structures (HCN)

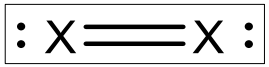
1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

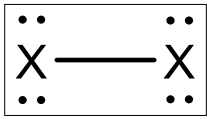
Lewis Structures

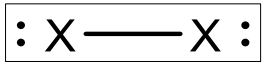
Which structure satisfies the octet rule for a compound made of generic element X?

A. 

B. 

C. 

D. 

E. 

Lewis Structures of Polyatomic Ions

- Polyatomic ions consist of two or more atoms covalently bonded together that have a net positive or negative charge.
- Lewis structures for polyatomic ions are drawn following the same guidelines as for neutral molecules with a few minor additions.
- You must consider the charge when summing the valence electrons in step 1.
  - Add a valence electron for each negative charge on an anion.
  - Subtract a valence electron for each positive charge on a cation.
- Place the structure within brackets, with the charge indicated outside the brackets.

Drawing Lewis Structures (NH_4^+)

1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed

Drawing Lewis Structures (CN^-)

1. Count the valence electrons
2. Arrange atoms by placing the least electronegative elements in the middle
3. Add single bonds
4. Add remaining electrons
5. Check octet and duet rules to determine whether multiple bonds are needed